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AN EXAMINATION OF THE PERFORMANCE OF TWO ACCEPTANCE DECISION RULES FOR CURTAILED WALD SEQUENTIAL SAMPLING PLANS

Bambang Murgiyanto

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THESIS

AN EXAMINATION OF THE PERFORMANCE
OF TWO ACCEPTANCE DECISION RULES FOR
CURTAILED WALD SEQUENTIAL SAMPLING PLANS

by

Bambang Murgiyanto

March 1980

Thesis Advisor: G. F. Lindsay

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T194315

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) An Examination of the Performance of Two Acceptance Decision Rules for Curtailed Wald Sequential Sampling Plans		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; March 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Bambang Murgiyanto		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE March 1980
		13. NUMBER OF PAGES 63
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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(continuation of abstract)

procedure uses the relative position of the last observation between the rejection and acceptance lines to determine the stopping rules. Computer programs are used to simulate the sampling process, providing estimates of operating characteristic points.

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An Examination of the Performance of Two Acceptance Decision Rules for Curtailed Wald Sequential Sampling Plans

by

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Lieutenant, Indonesian Navy
B.S., Indonesian Naval Academy, 1969

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
March 1980

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ABSTRACT

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Note: Type I and Type II errors were set constant for all simulations, where $\alpha = 0.05$ and $\beta = 0.10$
Truncation points were computed as percentages of n (see Table 1)

ACKNOWLEDGEMENT

I wish to thank Professor Glenn F. Lindsay for his guidance and advice throughout this study.

I. INTRODUCTION

In a Wald Sequential Probability Ratio (SPR) Sampling Plan, sample size is a random variable and we can not determine the number of items to be inspected in advance. It could be a large or small number. This uncertainty could be prohibitive whenever the sampling budget is limited or time for a decision is constrained. In many cases it is preferable, for a variety of reasons, to have a finite upper bound on sample size. However, a general policy has not been found which determines how a final decision at the point of truncation should be made so as to conform to stated acceptable risks.

The purpose of this paper is to examine the implications on acceptance sampling decisions when the Wald SPR sampling process is truncated by some predetermined sample number, and the final decision may therefore be based on statistics computed at the point of truncation. Two procedures are proposed to determine the decision rules for accepting a lot if sampling reaches the truncation line: (i) a least square fitted line method and (ii), a relative position of last observation method.

In order to evaluate the implications of the proposed procedures on the risks associated with the sampling plan a computer simulation of the curtailed and uncurtailed Wald

SPR sampling process is used, providing estimates of the probability of acceptance for various values of lot fraction defective. The Operating Characteristic (O.C.) curve of the curtailed and uncurtailed sampling are plotted in the same graph using a second Fortran computer program by the Versaplot-07 Plotting System available in Naval Postgraduate School Computer Center.

The presentation starts with the nature of the problem which describes the method, the problem, and proposes two approaches to the problem. These are given in Chapter II. A description of the actual decision procedures and how the simulation was done is given in Chapter III. In the last chapter, the results of the simulation and the graphs of O.C. curves are discussed, and conclusions are drawn.

II. NATURE OF THE PROBLEM

In general, truncating a sequential sampling plan will increase the probability of type I and type II errors. The exact functional relationship between the size of error and the sample size of truncated sequential sampling is not yet known. However, its upper bound may be derived [B.K. Ghosh, Ref. 4, pp. 223].

The purpose of this chapter is to: describe the general concepts of Wald SPR Sampling Plan and its Average Sample Number; discuss considerations in the curtailment of sequential sampling; and describe two proposed procedures to determine decision rules for truncated sequential sampling plans.

A. WALD SEQUENTIAL PROBABILITY RATIO SAMPLING PLAN

Abraham Wald [Ref. 9] simplifies the process of sequential sampling by a scoring method with acceptance and rejection boundaries which will meet some preassigned requirements. If the score at any time becomes larger than the first boundary (i.e., rejection line) the lot is rejected. If it falls below the second boundary (i.e., acceptance line) the lot is accepted. There are four specification requirements which completely determine Wald SPR Sampling Plan for fraction defective. Those specification requirements are:

1. p_1', the acceptable quality level for the lot, expressed as a fraction defective,

2. p_2', the lot tolerance fraction defective, expressed as a fraction defective where $p_2' > p_1'$,

3. α , probability of rejecting lots of quality p_1',

4. β , probability of accepting lots of quality p_2'.

Graphically, a Wald SPR sampling procedure can be described as follows. Consider a chart which consists of a vertical axis representing the number of defectives, a horizontal axis representing the number of items inspected and a pair of parallel straight lines with positive slope which are uniquely determined by the specification requirements. During the sequence of inspection the total number of defectives is plotted against the total number of items inspected on the chart. As long as the plotted points fall between two lines, the inspection continues. An inspection terminates when a plotted point falls on or outside either of the lines.

Defining upper line by R and lower line by A, where R and A are functions of sample number, the equations of the lines may be written as

$$R = h_2 + sn$$

and

$$A = -h_1 + sn,$$

where R will give a rejection number and A will give an acceptance number at sample number n. The constants s, h_1 and h_2 are the slope and the intercepts and their equations may be written as follows [Ref. 8, pp. 2.14] :

$$s = \frac{\log \dfrac{(1 - p_2')}{(1 - p_1')}}{\log \dfrac{p_1'(1 - p_2')}{p_2'(1 - p_1')}} , \quad (3)$$

$$h_1 = \frac{\log \dfrac{(1 - \alpha)}{\beta}}{\log \dfrac{p_1'(1 - p_2')}{p_2'(1 - p_1')}} , \quad (4)$$

and

$$h_2 = \frac{\log \dfrac{(1 - \beta)}{\alpha}}{\log \dfrac{p_1'(1 - p_2')}{p_2'(1 - p_1')}} . \quad (5)$$

In these equations, it is necessary that p_1' must be less than p_2' and $\alpha + \beta$ is less than unity, so that quantities obtained before applying algorithms are always positive.

B. AVERAGE SAMPLE NUMBER (ASN)

Since sample size is a random variable, it is not possible to determine exactly how many items from a lot have to be inspected, but it is possible to compute the average

depends on quantities h_1 , h_2 , and s. The equations are as follows [Ref. 8, pp. 2.51]:

$$n_{p'} = \frac{P\,(h_1 + h_2) - h_2}{s - p'} \qquad ,$$

where P is the probability of accepting a lot of quality p', and h_1 , h_2 , and s are computed from the specification requirements. In particular when $p' = p_1'$, we have

$$n_{p_1'} = \frac{(1-\alpha)\,h_1 - \alpha\,h_2}{s - p_1'} \qquad ,$$

when $p' = p_2'$, we have

$$n_{p_2'} = \frac{(1-\beta)\,h_2 - \beta\,h_1}{p_2' - s} \qquad ,$$

and when $p' = s$, we have

$$n_s = \frac{(h_1 \cdot h_2)}{s\,(1 - s)} \qquad .$$

Note that $p_1' < s < p_2'$ and in general $n_{p_1'} < n_s$. We normally observe an increasing average amount of inspection as p' goes from zero to p_1', and a decreasing amount of inspection as p' goes from p_2' to unity. Hence the greatest ASN is required for a lot with quality between p_1' and p_2'. In addition, the greater the risk sizes α and β are, the smaller also the ASN. These properties are useful when we discuss the curtailment of sequential sampling.

Figure 1 shows a typical ASN curve. The vertical axis represents $n_{p'}$, the average sample number, and the horizontal axis represents p', fraction defective of lot.

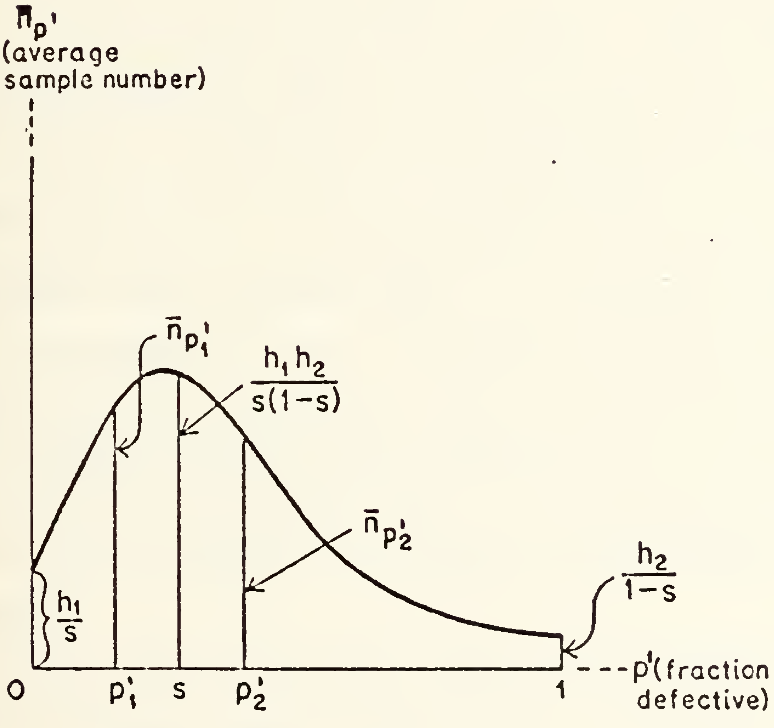

FIGURE 1. A TYPICAL ASN CURVE

C. CURTAILMENT OF SEQUENTIAL SAMPLING

As mentioned before, the number of samples required in sequential sampling to achieve a conclusive decision is not a constant but a random variable. In practice it may be desirable to have an upper bound on sample size. Setting the sample number constant could increase risk size, since the sequential process may or may not terminate before the truncation point. Two steps could be considered: (i) Try to reduce ASN, (ii) Modify the sequential sampling plan. The first step may require a compromise among the quantities α, β, p_1', and p_2'. A property of the ASN states that the greater α and β or the larger the difference between p_1' and p_2', the smaller the ASN will be. We could then make adjustments either in the quality limit (i.e., p_1' and p_2') or in the size of risks (i.e. α and β) or both. But this compromise might not be applicable if the specification requirements are strictly kept. The second step is suggested by J. J. Bussgang and M. B. Marcus in Reference 1. Instead of using a pair of straight lines as the boundaries, they propose "gently sloping" lines as the boundaries so that they would monotonically converse as the sample number increases.

In both steps the given point of truncation must be determined sufficiently beyond ASN so that most of the sampling terminates before the truncation point is reached. This is clear because otherwise probabilities of the first and second kind of errors will increase. The two above

procedures have limitations on their applicability. Now, let us develop two simple procedures.

The first procedure uses the slope of a least-square fitted line as an estimator for the direction of the plotted sequential sampling, and this slope is compared with the slope of boundary lines computed from specification requirements. The second procedure uses the fact that when sample size is sufficiently large, the total defectives will either close to the rejection line or close to the acceptance line, with the probability of eventually crossing either line equal to unity. Further discussion of the proposed procedures is given in the next section.

D. PROPOSED PROCEDURES

Consider a Wald SPR sampling plan with specified α, β, p_1', and p_2'. Let n' denote the maximum sample number to be allowed, which is determined before the sampling begins.

1. Least Square Fitted Line Method

Suppose up to n' there is no decision made either to accept or to reject the lot. By then we have observed:

$$(1,X_1),\ (2,X_2),\ (3,X_3),\ .\ .\ .,(n,X_n),\ .\ .\ .\ ,\ (n',X_{n'})$$

where n is the sample number and X_n is number of defectives found in n observations. A least-square line fitted from the origin through the observed samples will have a slope given by:

$$b = \frac{\sum_{n=1}^{n'} X_n}{\sum_{n=1}^{n'} n} \quad ,$$

where X_n is number of defectives at stage n, and $\sum_{n=1}^{n'} n$ can be simplified by

$$\sum_{n=1}^{n'} n = \frac{(1 + n')\,n'}{2} \quad ,$$

wielding

$$b = \frac{(1 + n')\,n'}{2} \sum_{n=1}^{n'} X_n \ . \qquad [6]$$

Let us compare the slope of the least-square fitted line b with the slope of the boundary lines s. The decision rules are given as follows. If b is greater than s we reject the lot and terminate sampling. If b is equal to or less than s we accept the lot and terminate sampling.

2. Relative Position of Last Observation Method

Again, suppose up to n' observations no decision can be made. This means that X_n is always between the boundary lines for n = 1, 2, 3, ... n'. For a lot with quality better than p_1', the number of defectives tends to close to

the acceptance line if n is getting larger. On the otherhand for a lot with quality worse than p_2', the number of defectives tends to close to the rejection line if n is getting larger. Let us take a constant distance above acceptance line, denoted by d. We can then define a new acceptance number A', where

$$A' = d - h_1 + s\,n' \quad . \qquad [7]$$

The decision rules are given as follows. If $X_{n'}$ is greater than A', reject the lot and terminate sampling. If $X_{n'}$ is equal or less than A', accept the lot and terminate sampling. Implementation of either of these procedures will have an impact on acceptance probability, and the curtailed plan should have a different O.C. curve from the original uncurtailed plan. The magnitude of the change of the O.C. curve may be evaluated by simulation. The simulation procedures are described in the next chapter.

III. EXPERIMENTAL PROCEDURES

There are three distinct steps in acceptance sequential sampling by attributes. First, determination of objectives or specifications, second classification or good or bad items, and third a valid procedure of inspection.

The experimental procedures discussed in this chapter are presented in accordance with those three steps, and then used to evaluate the implications of the two proposed stopping rules on the plan's operating characteristic curve by utilizing computer simulation.

A. PROCEDURE I

In finding a Wald SPR sampling plan for fraction defective, the specification requirements α, β, p_1', and p_2' are used to compute s, h_1, and h_2 using Equations (3), (4) and (5), and these give the equations of the acceptance and rejection lines as functions of n. Now, we consider lots of quality p'. We draw items from the lot, one at a time, and classify each as good or defective, defining X_n as the number of defectives found up through the first n items. If X_n is equal to or greater than the rejection number we terminate the sampling and reject the lot. If X_n is equal to or less than the acceptance number we terminate sampling and accept the lot. Otherwise we repeat sampling until n = n', where n' is the curtailment point. At stage n' we compute the slope b by Equation (6) and compare it with s. If b is

greater than s we reject the lot; if b is equal to or less than s we accept the lot. In both cases the sampling process terminates.

In simulation of the use of this stopping rule, the overall sequential sampling is replicated through k lots, where k is a large number. The probability of acceptance of a lot of quality p' is estimated by the number of accepted lots divided by k. If we repeat the whole process for different p' then we will obtain additional points of the O.C. curve for this curtailed sequential sampling plan.

The truncation points are computed before the sampling begins. In this paper n' is computed as percentages of n_s, since it represents the largest ASN.

B. PROCEDURE II

The Procedure II is similar to Procedure I except that at the truncation point, $X_{n'}$ is compared to an acceptance number A', where A' is a function of d and computed using Equation (7). By trial and error it turns out that for large n', the value of A' is approximately equal to sn' since d is approximately equal to h_1. However, for small n' it gives poor O.C. curve. The stopping rules are then: if $X_{n'}$ is equal or less than sn', accept the lot and terminate sampling. Otherwise reject the lot and terminate sampling.

The simulation of the two procedures at different truncation points was done simultaneously with the uncurtailed sampling. The details of the simulation are given in the next section.

C. COMPUTER SIMULATION

Monte Carlo simulation was used to simulate the Wald SPR sampling process. The computer programs were written in Fortran IV and utilized the IBM-360 computer at the Naval Postgraduate School Computer Center in the period of October 1979 to March 1980.

Input variables consist of the four specification requirements (denoted by A, B, P1 and P2), the number of replications, and the number of points on O.C. curve. A uniform random generator (GGUBS) with double precision was used to classify as good or as bad an item from a lot. To save computer time, the simulation of both procedures each with 5 different truncation points and the simulation of the uncurtailed Wald SPR sampling were done simultaneously in one run for each pair of values for P1 and P2. Eighteen operating characteristic points were computed for each pair of values for P1 and P2, where P1 was given from one percent to ten percent and P2 was from five percent to thirty percent. The parameter values used to investigate the performance of each procedure are shown in Table 1.

A second computer program was written in Fortran IV to plot the O.C. curve of uncurtailed and curtailed sampling in one graph, where the data points were obtained from the first computer outputs. This will provide a visual representation of the difference between the two O.C. curves. The plots were done by Versatec-07 Plotting System available in the Naval Postgraduate School Computer Center.

Michael W. Gavlak [Ref. 3, pp. 24-26] stated that to simulate estimates of O.C. points for repeated Bernoulli trials with p' ranging from one percent to thirty percent, it is sufficient to take 5000 replications of each estimate within reasonable accuracy, namely two or three decimal places.

TABLE 1. PARAMETER VALUES USED IN SIMULATION

Prob of type I error	:	0.05
Prob of type II error	:	0.10
Acceptable quality levels	:	0.01, 0.05, 0.10
Lot quality tolerance values	:	0.05, 0.10, 0.15, 0.30
Number of replications	:	5000
Number of O.C. curve points	:	18
Percentages of n_s for curtailment	:	50, 75, 100, 125, 150

IV. RESULTS AND CONCLUSIONS

In general when Wald SPR sampling process is truncated with the same stopping rule, then its O.C. curve varies as the point of truncation varies. The larger the point of truncation, the closer its O.C. curve to the O.C. curve of uncurtailed sampling process. Using n_s, the average sample number when lot fraction defective is s, as standard for comparison, the graphs show that for n' greater than 150 percent of n_s, their O.C. curve gives good approximation to the O.C. curves of uncurtailed sampling, since most of the samplings terminate before n'.

Comparing the results of Procedure I and Procedure II, the numerical output shows that for large n', Procedure II gives better approximation to the uncurtailed O.C. curve. Further, Procedure II is a more simple method, hence it is more practical. The determination of constant d, however, needs further investigation, particularly for small n'.

For further investigation, notice that the Procedure I which requires the least-square fitted line through the origin raises question whether an ordinary least-square fitted line will give better approximation even though it may be less practical. Another area for further study may include the possibility of using the variance of ASN to determine the proper location of the truncation point.

In all, sixty cases were examined and twenty two of their O.C. curves were graphed. The tables of the first computer output and the results of the second computer program are presented below.

```
TABLE    2 . OPERATING CHARACTERISTIC CURVE VALUES FOR

             CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

             ACCEPTABLE QUALITY LEVEL (P1) :  0.010

             LOTS QUALITY TOLERANCE (P2)   :  0.050

             PROB OF TYPE I  ERROR (ALPHA) :  0.050

             PROB OF TYPE II ERROR (BETA)  :  0.100

             AVERAGE SAMPLE NUMBER (NS) :   98.

                                     PERCENT OF NS FOR CURTAILMENT
FRACDEF     UNCURT   !    50    !    75    !    100   !    125   !    150


0.0         1.000       1.000      1.000      1.000      1.000      1.000

0.004       0.998       0.928      0.967      0.983      0.987      0.994

0.007       0.990       0.863      0.913      0.939      0.951      0.967

0.011       0.961       0.791      0.844      0.871      0.887      0.909

0.014       0.910       0.730      0.772      0.800      0.812      0.840

0.018       0.829       0.665      0.704      0.714      0.725      0.747

0.021       0.724       0.613      0.628      0.638      0.639      0.654

0.025       0.602       0.549      0.558      0.552      0.547      0.553

0.029       0.482       0.507      0.497      0.478      0.468      0.470

0.032       0.381       0.454      0.437      0.400      0.382      0.373

0.036       0.302       0.414      0.385      0.351      0.323      0.319

0.039       0.224       0.361      0.326      0.293      0.265      0.251

0.043       0.175       0.318      0.282      0.249      0.215      0.199

0.046       0.143       0.293      0.241      0.204      0.175      0.164

0.050       0.105       0.248      0.201      0.164      0.141      0.126

0.054       0.078       0.235      0.177      0.141      0.113      0.097

0.061       0.044       0.178      0.128      0.087      0.064      0.054

0.068       0.026       0.137      0.082      0.053      0.038      0.032
```

TABLE 3 . OPERATING CHARACTERISTIC CURVE VALUES FOR CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.010

LOTS QUALITY TOLERANCE (P2) : 0.300

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 6.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	0.942	0.958	0.917	0.917	0.897	0.896
0.043	0.853	0.915	0.840	0.840	0.802	0.798
0.064	0.755	0.875	0.765	0.765	0.712	0.704
0.086	0.652	0.837	0.696	0.696	0.638	0.627
0.107	0.555	0.802	0.641	0.641	0.577	0.558
0.129	0.456	0.761	0.578	0.578	0.502	0.476
0.150	0.378	0.711	0.523	0.523	0.447	0.422
0.171	0.306	0.683	0.470	0.470	0.391	0.362
0.193	0.246	0.648	0.419	0.419	0.337	0.304
0.214	0.195	0.614	0.366	0.366	0.292	0.255
0.236	0.162	0.588	0.345	0.345	0.260	0.222
0.257	0.131	0.561	0.310	0.310	0.229	0.190
0.279	0.107	0.527	0.275	0.275	0.200	0.163
0.300	0.086	0.497	0.240	0.240	0.173	0.134
0.321	0.068	0.460	0.217	0.217	0.145	0.108
0.364	0.041	0.412	0.164	0.164	0.100	0.070
0.407	0.022	0.338	0.110	0.110	0.065	0.041

TABLE 4 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.050

LOTS QUALITY TOLERANCE (P2) : 0.100

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 174.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT	50	75	100	125	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.007	1.000	1.000	1.000	1.000	1.000	1.000
0.014	1.000	0.998	1.000	1.000	1.000	1.000
0.021	1.000	0.987	0.997	1.000	1.000	1.000
0.029	0.998	0.969	0.987	0.994	0.997	0.997
0.036	0.996	0.927	0.964	0.980	0.989	0.993
0.043	0.987	0.871	0.916	0.943	0.961	0.972
0.050	0.958	0.806	0.849	0.881	0.906	0.921
0.057	0.902	0.726	0.764	0.794	0.821	0.844
0.064	0.773	0.624	0.644	0.663	0.681	0.699
0.071	0.603	0.536	0.538	0.541	0.550	0.558
0.079	0.421	0.462	0.444	0.426	0.417	0.413
0.086	0.274	0.385	0.347	0.323	0.301	0.292
0.093	0.164	0.287	0.241	0.218	0.198	0.185
0.100	0.098	0.240	0.183	0.147	0.125	0.115
0.107	0.065	0.200	0.142	0.106	0.085	0.075
0.121	0.023	0.106	0.060	0.039	0.030	0.026
0.136	0.007	0.060	0.027	0.012	0.009	0.007

TABLE 5 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.050

LOTS QUALITY TOLERANCE (P2) : 0.300

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 12.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	0.996	0.939	0.936	0.950	0.982	0.984
0.043	0.979	0.876	0.868	0.885	0.935	0.937
0.064	0.943	0.820	0.802	0.816	0.868	0.874
0.086	0.886	0.770	0.748	0.755	0.802	0.805
0.107	0.792	0.708	0.674	0.665	0.714	0.710
0.129	0.676	0.645	0.599	0.573	0.612	0.604
0.150	0.556	0.599	0.547	0.519	0.545	0.525
0.171	0.448	0.553	0.483	0.449	0.468	0.445
0.193	0.343	0.508	0.435	0.378	0.384	0.357
0.214	0.265	0.465	0.392	0.334	0.333	0.306
0.236	0.207	0.430	0.350	0.284	0.276	0.247
0.257	0.154	0.386	0.301	0.230	0.225	0.197
0.279	0.119	0.344	0.253	0.191	0.183	0.152
0.300	0.073	0.309	0.215	0.147	0.130	0.099
0.321	0.060	0.274	0.185	0.124	0.106	0.087
0.364	0.031	0.217	0.134	0.078	0.065	0.046
0.407	0.017	0.173	0.092	0.047	0.035	0.023

TABLE 6 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.100

LOTS QUALITY TOLERANCE (P2) : 0.150

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 281.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.011	1.000	1.000	1.000	1.000	1.000	1.000
0.021	1.000	1.000	1.000	1.000	1.000	1.000
0.032	1.000	1.000	1.000	1.000	1.000	1.000
0.043	1.000	1.000	1.000	1.000	1.000	1.000
0.054	1.000	0.997	1.000	1.000	1.000	1.000
0.064	1.000	0.986	0.998	0.999	1.000	1.000
0.075	0.998	0.960	0.984	0.994	0.998	0.998
0.086	0.993	0.919	0.952	0.973	0.985	0.989
0.096	0.975	0.836	0.885	0.916	0.936	0.947
0.107	0.894	0.725	0.770	0.801	0.826	0.847
0.118	0.707	0.590	0.602	0.618	0.635	0.648
0.129	0.453	0.445	0.439	0.431	0.430	0.431
0.139	0.226	0.332	0.298	0.269	0.255	0.241
0.150	0.101	0.230	0.180	0.149	0.126	0.115
0.161	0.042	0.155	0.100	0.075	0.060	0.050
0.182	0.008	0.051	0.024	0.015	0.009	0.008
0.204	0.001	0.012	0.003	0.002	0.001	0.001

TABLE 7 . OPERATING CHARACTERISTIC CURVE VALUES FOR CURTAILED SAMPLING BY LEAST SQUARE LINE METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.100
LOTS QUALITY TOLERANCE (P2) : 0.300
PROB OF TYPE I ERROR (ALPHA) : 0.050
PROB OF TYPE II ERROR (BETA) : 0.100
AVERAGE SAMPLE NUMBER (NS) : 24.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT	50	75	100	125	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	1.000	0.989	0.995	0.998	1.000	1.000
0.043	0.999	0.960	0.975	0.990	0.995	0.997
0.064	0.995	0.913	0.941	0.964	0.978	0.986
0.086	0.985	0.855	0.888	0.924	0.943	0.960
0.107	0.956	0.801	0.819	0.851	0.872	0.897
0.129	0.894	0.731	0.745	0.767	0.786	0.812
0.150	0.811	0.672	0.667	0.690	0.703	0.728
0.171	0.677	0.596	0.581	0.592	0.593	0.608
0.193	0.553	0.533	0.506	0.504	0.496	0.509
0.214	0.404	0.473	0.434	0.416	0.400	0.402
0.236	0.291	0.413	0.360	0.333	0.310	0.306
0.257	0.211	0.365	0.312	0.276	0.249	0.238
0.279	0.143	0.315	0.245	0.214	0.180	0.168
0.300	0.089	0.257	0.187	0.148	0.124	0.111
0.321	0.067	0.224	0.156	0.121	0.092	0.081
0.364	0.028	0.154	0.089	0.057	0.040	0.034
0.407	0.012	0.104	0.051	0.028	0.018	0.015

TABLE 8 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.010
LOTS QUALITY TOLERANCE (P2) : 0.050
PROB OF TYPE I ERROR (ALPHA) : 0.050
PROB OF TYPE II ERROR (BETA) : 0.100
AVERAGE SAMPLE NUMBER (NS) : 98.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT	50	75	100	125	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.004	0.998	0.985	0.974	0.994	0.998	0.997
0.007	0.990	0.952	0.909	0.970	0.985	0.979
0.011	0.961	0.901	0.817	0.907	0.949	0.931
0.014	0.910	0.842	0.733	0.841	0.899	0.861
0.018	0.829	0.779	0.640	0.759	0.820	0.763
0.021	0.724	0.716	0.556	0.671	0.745	0.667
0.025	0.602	0.649	0.470	0.575	0.642	0.558
0.029	0.482	0.591	0.397	0.493	0.549	0.461
0.032	0.381	0.532	0.330	0.406	0.458	0.367
0.036	0.302	0.486	0.286	0.347	0.386	0.309
0.039	0.224	0.419	0.236	0.285	0.314	0.237
0.043	0.175	0.375	0.195	0.234	0.257	0.189
0.046	0.143	0.335	0.162	0.189	0.209	0.155
0.050	0.105	0.280	0.132	0.156	0.166	0.114
0.054	0.078	0.261	0.109	0.121	0.127	0.087
0.061	0.044	0.189	0.069	0.069	0.074	0.049
0.068	0.026	0.144	0.043	0.043	0.044	0.028

TABLE 9 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.010

LOTS QUALITY TOLERANCE (P2) : 0.300

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 6.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT	50	75	100	125	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	0.942	0.958	0.917	0.897	0.877	0.858
0.043	0.853	0.915	0.840	0.802	0.765	0.732
0.064	0.755	0.875	0.765	0.712	0.669	0.626
0.086	0.652	0.837	0.696	0.638	0.585	0.536
0.107	0.555	0.802	0.641	0.577	0.513	0.459
0.129	0.456	0.761	0.578	0.502	0.438	0.380
0.150	0.378	0.711	0.523	0.447	0.382	0.322
0.171	0.306	0.683	0.470	0.391	0.319	0.261
0.193	0.246	0.648	0.419	0.337	0.274	0.222
0.214	0.195	0.614	0.366	0.292	0.225	0.175
0.236	0.162	0.588	0.345	0.260	0.196	0.148
0.257	0.131	0.561	0.310	0.229	0.167	0.122
0.279	0.107	0.527	0.275	0.200	0.145	0.102
0.300	0.086	0.497	0.240	0.173	0.118	0.082
0.321	0.068	0.460	0.217	0.145	0.098	0.064
0.364	0.041	0.412	0.164	0.100	0.061	0.040
0.407	0.022	0.338	0.110	0.065	0.037	0.021

TABLE 10 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.050

LOTS QUALITY TOLERANCE (P2) : 0.100

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 174.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT	50	75	100	125	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.007	1.000	1.000	1.000	1.000	1.000	1.000
0.014	1.000	1.000	1.000	1.000	1.000	1.000
0.021	1.000	0.997	1.000	1.000	1.000	1.000
0.029	0.998	0.987	0.995	0.997	0.997	0.998
0.036	0.996	0.966	0.982	0.990	0.993	0.996
0.043	0.987	0.923	0.945	0.964	0.974	0.980
0.050	0.958	0.865	0.890	0.913	0.927	0.935
0.057	0.902	0.789	0.803	0.822	0.842	0.859
0.064	0.773	0.681	0.675	0.693	0.705	0.717
0.071	0.603	0.584	0.564	0.561	0.559	0.566
0.079	0.421	0.492	0.431	0.423	0.413	0.407
0.086	0.274	0.400	0.344	0.309	0.291	0.279
0.093	0.164	0.298	0.234	0.204	0.190	0.181
0.100	0.098	0.238	0.160	0.135	0.115	0.107
0.107	0.065	0.183	0.119	0.090	0.077	0.071
0.121	0.023	0.096	0.047	0.033	0.025	0.024
0.136	0.007	0.044	0.016	0.009	0.007	0.007

TABLE 11 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.050

LOTS QUALITY TOLERANCE (P2) : 0.300

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 12.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	0.996	0.901	0.987	0.978	0.995	0.993
0.043	0.979	0.798	0.956	0.924	0.972	0.964
0.064	0.943	0.717	0.909	0.848	0.934	0.908
0.086	0.886	0.652	0.860	0.775	0.882	0.837
0.107	0.792	0.565	0.798	0.681	0.810	0.747
0.129	0.676	0.498	0.714	0.577	0.724	0.640
0.150	0.556	0.448	0.658	0.502	0.636	0.543
0.171	0.448	0.382	0.592	0.433	0.554	0.454
0.193	0.343	0.336	0.523	0.347	0.462	0.360
0.214	0.265	0.299	0.470	0.306	0.395	0.304
0.236	0.207	0.270	0.410	0.246	0.333	0.244
0.257	0.154	0.225	0.351	0.201	0.272	0.191
0.279	0.119	0.194	0.299	0.165	0.219	0.145
0.300	0.073	0.157	0.251	0.118	0.155	0.097
0.321	0.060	0.139	0.215	0.095	0.130	0.081
0.364	0.031	0.099	0.146	0.056	0.070	0.040
0.407	0.017	0.071	0.103	0.031	0.039	0.021

TABLE 12 . OPERATING CHARACTERISTIC CURVE VALUES FOR
CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.100

LOTS QUALITY TOLERANCE (P2) : 0.150

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 281.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.011	1.000	1.000	1.000	1.000	1.000	1.000
0.021	1.000	1.000	1.000	1.000	1.000	1.000
0.032	1.000	1.000	1.000	1.000	1.000	1.000
0.043	1.000	1.000	1.000	1.000	1.000	1.000
0.054	1.000	1.000	1.000	1.000	1.000	1.000
0.064	1.000	0.996	0.999	1.000	1.000	1.000
0.075	0.998	0.982	0.989	0.998	0.998	0.998
0.086	0.993	0.946	0.966	0.984	0.990	0.991
0.096	0.975	0.879	0.898	0.936	0.956	0.963
0.107	0.894	0.764	0.772	0.824	0.856	0.870
0.118	0.707	0.615	0.595	0.639	0.667	0.673
0.129	0.453	0.465	0.408	0.439	0.454	0.463
0.139	0.226	0.326	0.258	0.259	0.261	0.255
0.150	0.101	0.212	0.143	0.133	0.124	0.115
0.161	0.042	0.128	0.069	0.062	0.052	0.047
0.182	0.008	0.034	0.015	0.011	0.008	0.008
0.204	0.001	0.007	0.002	0.001	0.001	0.001

TABLE 13 . OPERATING CHARACTERISTIC CURVE VALUES FOR CURTAILED SAMPLING BY LAST OBSERVATION METHOD

ACCEPTABLE QUALITY LEVEL (P1) : 0.100

LOTS QUALITY TOLERANCE (P2) : 0.300

PROB OF TYPE I ERROR (ALPHA) : 0.050

PROB OF TYPE II ERROR (BETA) : 0.100

AVERAGE SAMPLE NUMBER (NS) : 24.

		PERCENT OF NS FOR CURTAILMENT				
FRACDEF	UNCURT !	50 !	75 !	100 !	125 !	150
0.0	1.000	1.000	1.000	1.000	1.000	1.000
0.021	1.000	0.998	1.000	1.000	1.000	1.000
0.043	0.999	0.991	0.995	0.997	0.998	0.999
0.064	0.995	0.973	0.981	0.987	0.990	0.993
0.086	0.985	0.942	0.954	0.965	0.970	0.975
0.107	0.95[illegible]	0.890	0.900	0.909	0.920	0.930
0.129	0.894	0.839	0.830	0.835	0.840	0.849
0.150	0.811	0.783	0.769	0.763	0.752	0.760
0.171	0.677	0.709	0.667	0.649	0.644	0.637
0.193	0.553	0.638	0.583	0.561	0.544	0.533
0.214	0.404	0.573	0.501	0.459	0.431	0.413
0.236	0.291	0.494	0.407	0.359	0.322	0.307
0.257	0.211	0.446	0.349	0.292	0.255	0.236
0.279	0.143	0.374	0.271	0.216	0.181	0.161
0.300	0.089	0.302	0.205	0.147	0.122	0.110
0.321	0.067	0.266	0.163	0.117	0.089	0.077
0.364	0.028	0.169	0.080	0.051	0.037	0.030
0.407	0.012	0.118	0.046	0.024	0.017	0.014

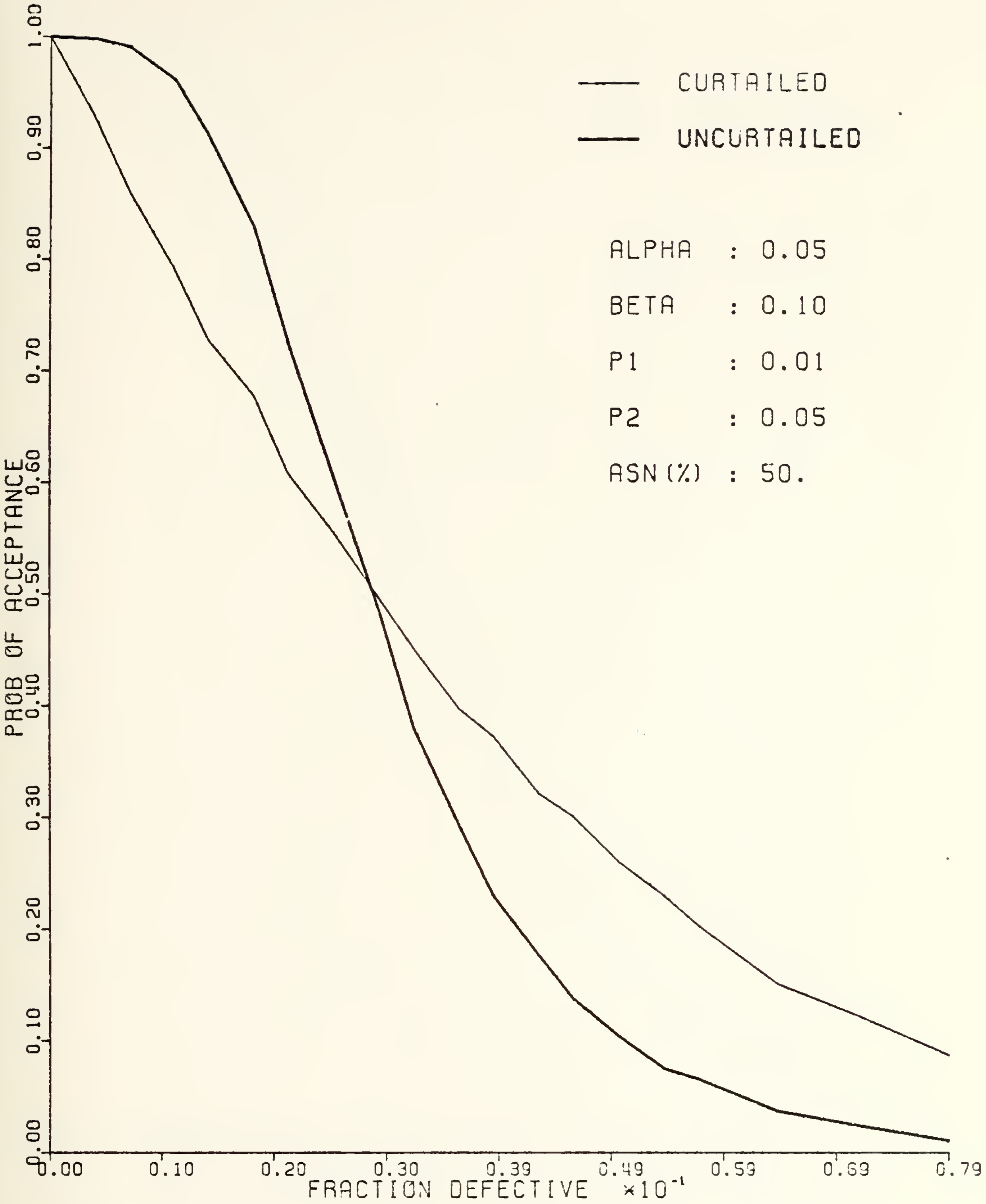

FIGURE 2 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

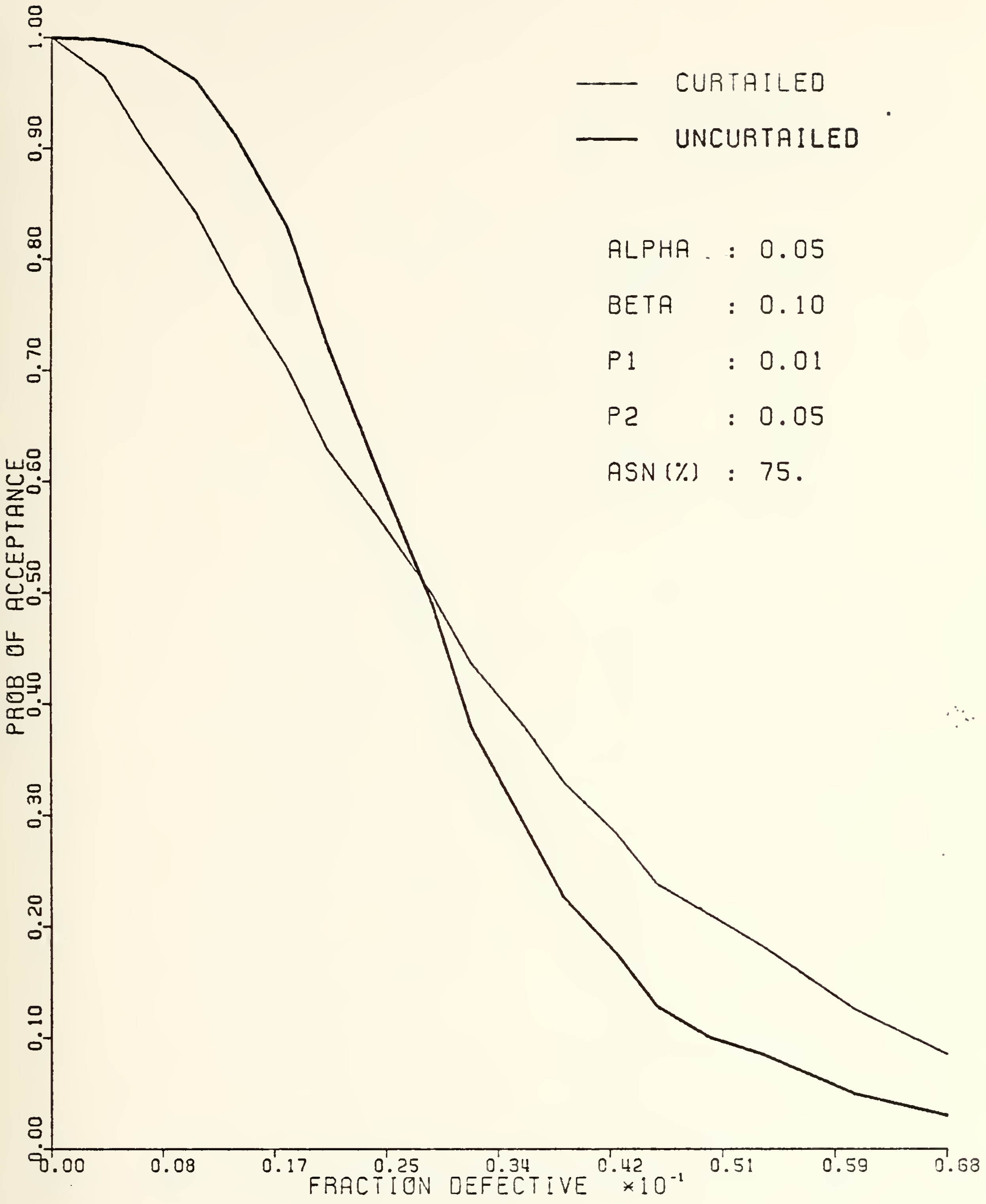

FIGURE 3 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

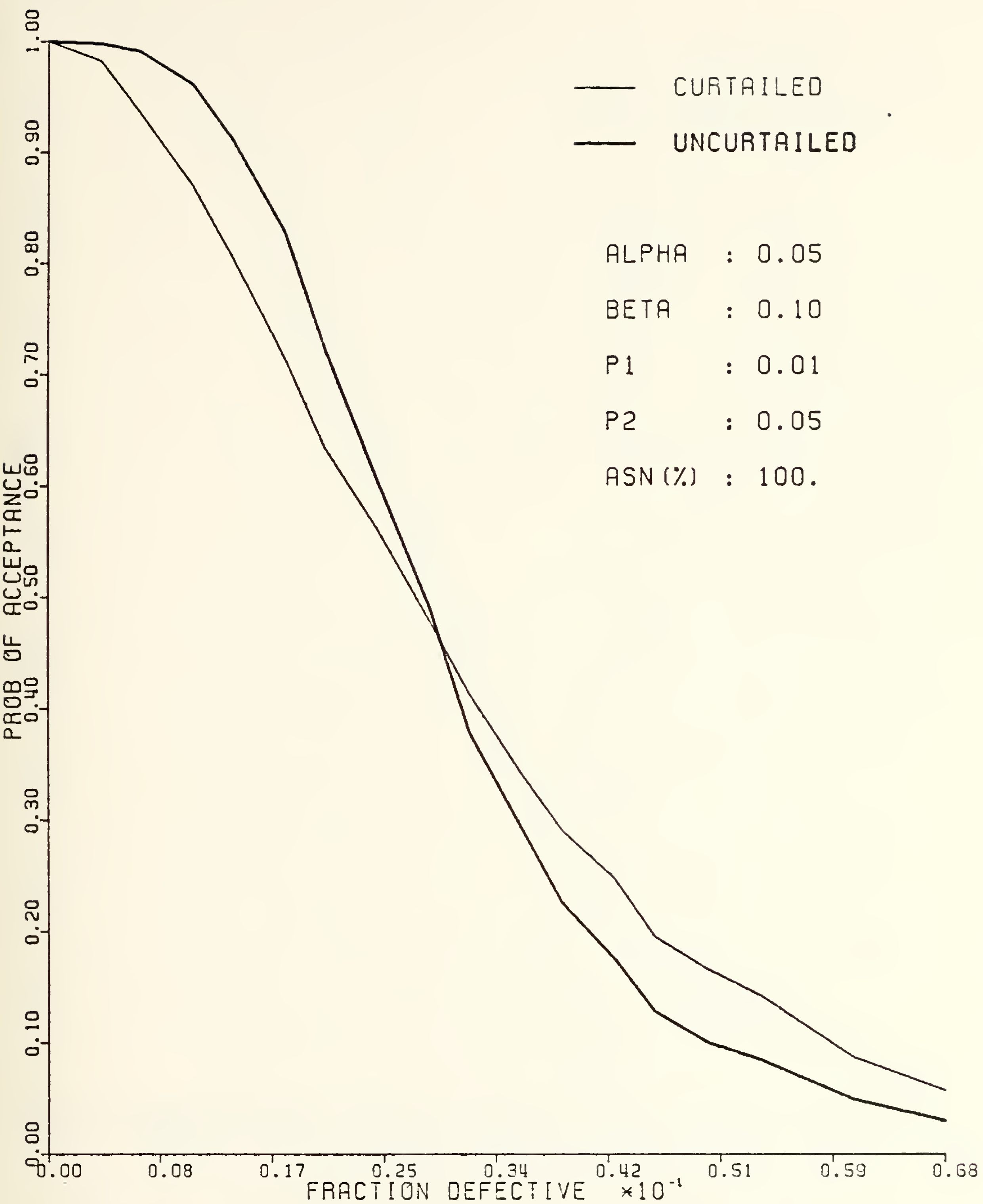

FIGURE 4 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

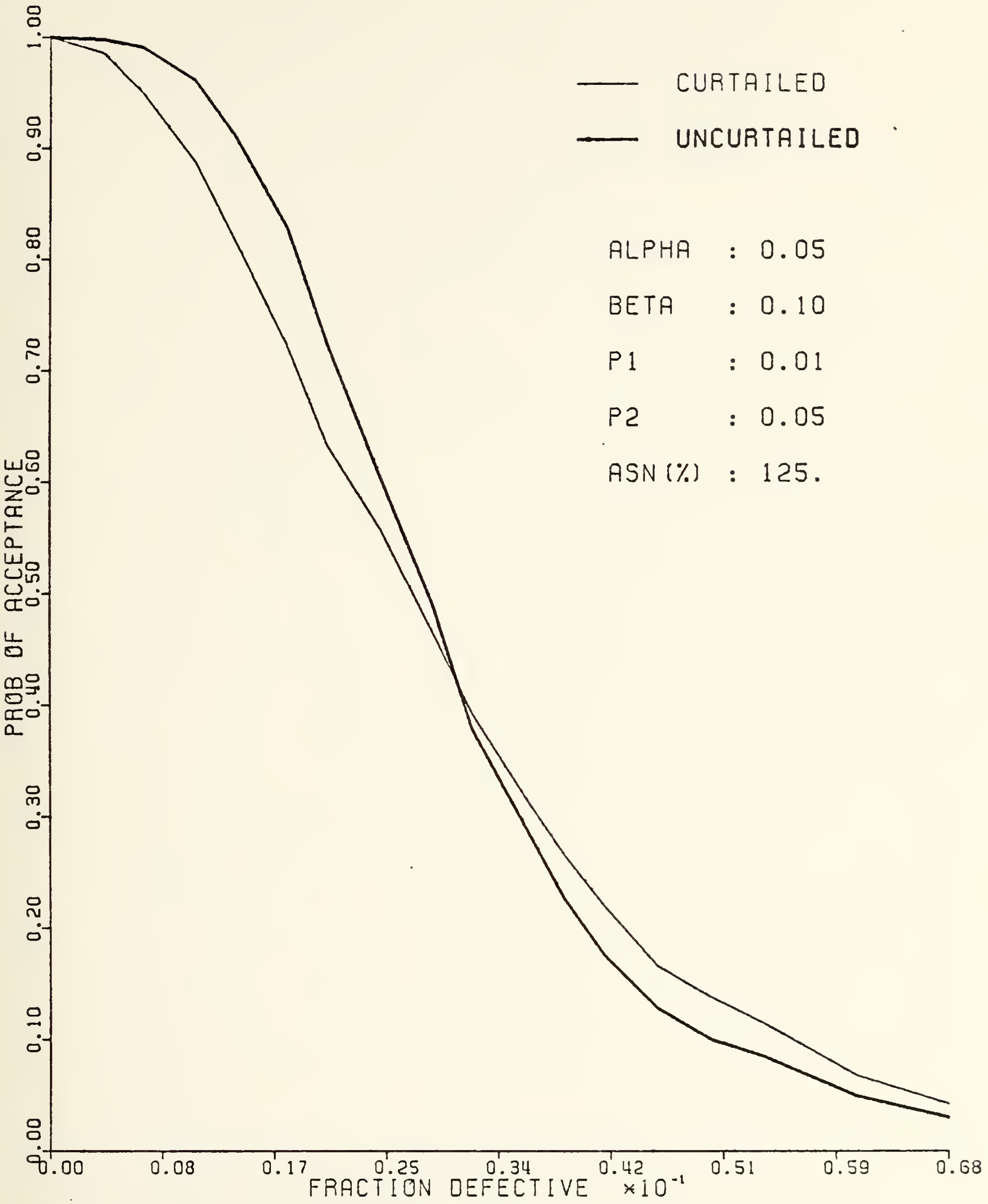

FIGURE 5 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

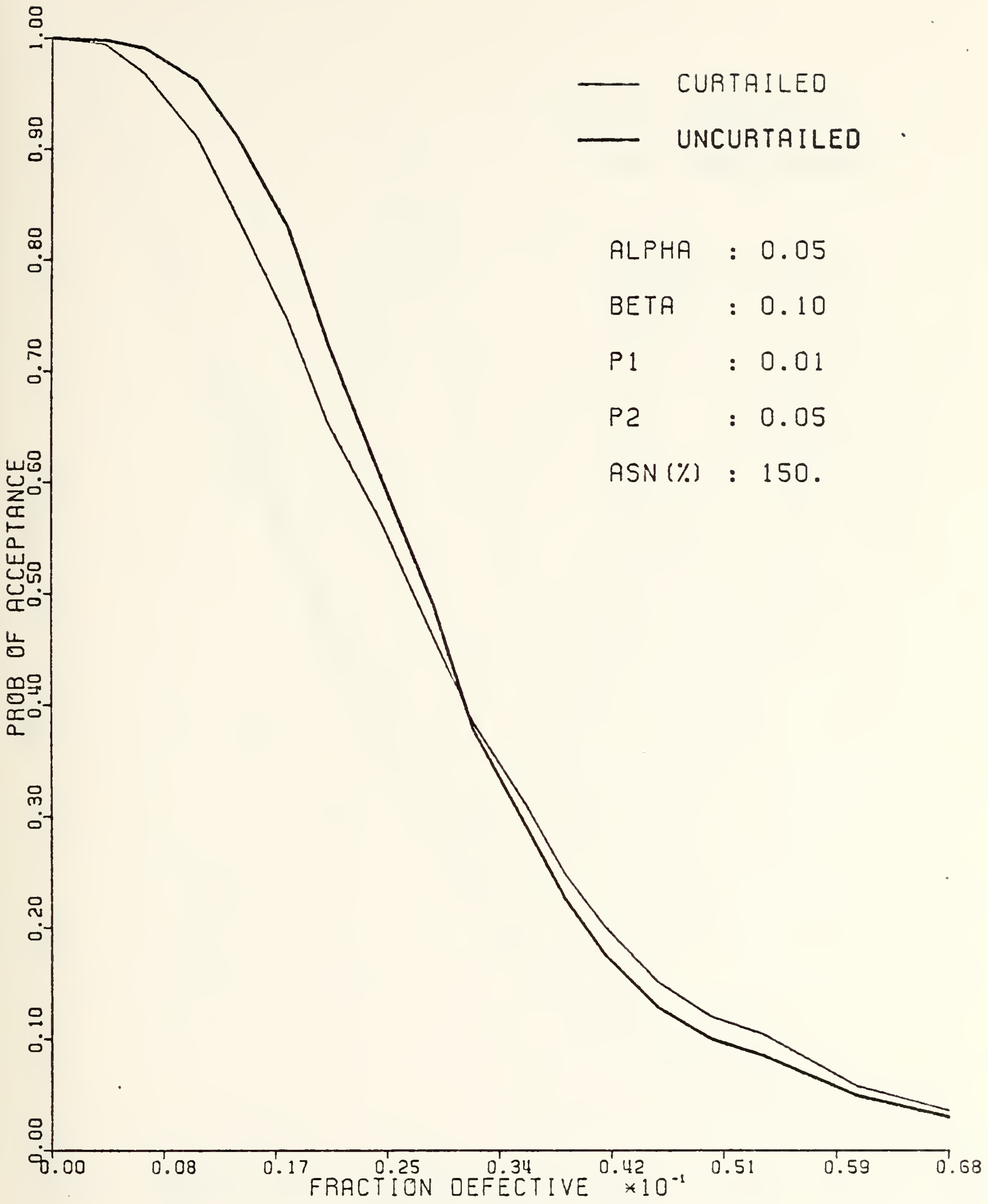

FIGURE 6 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

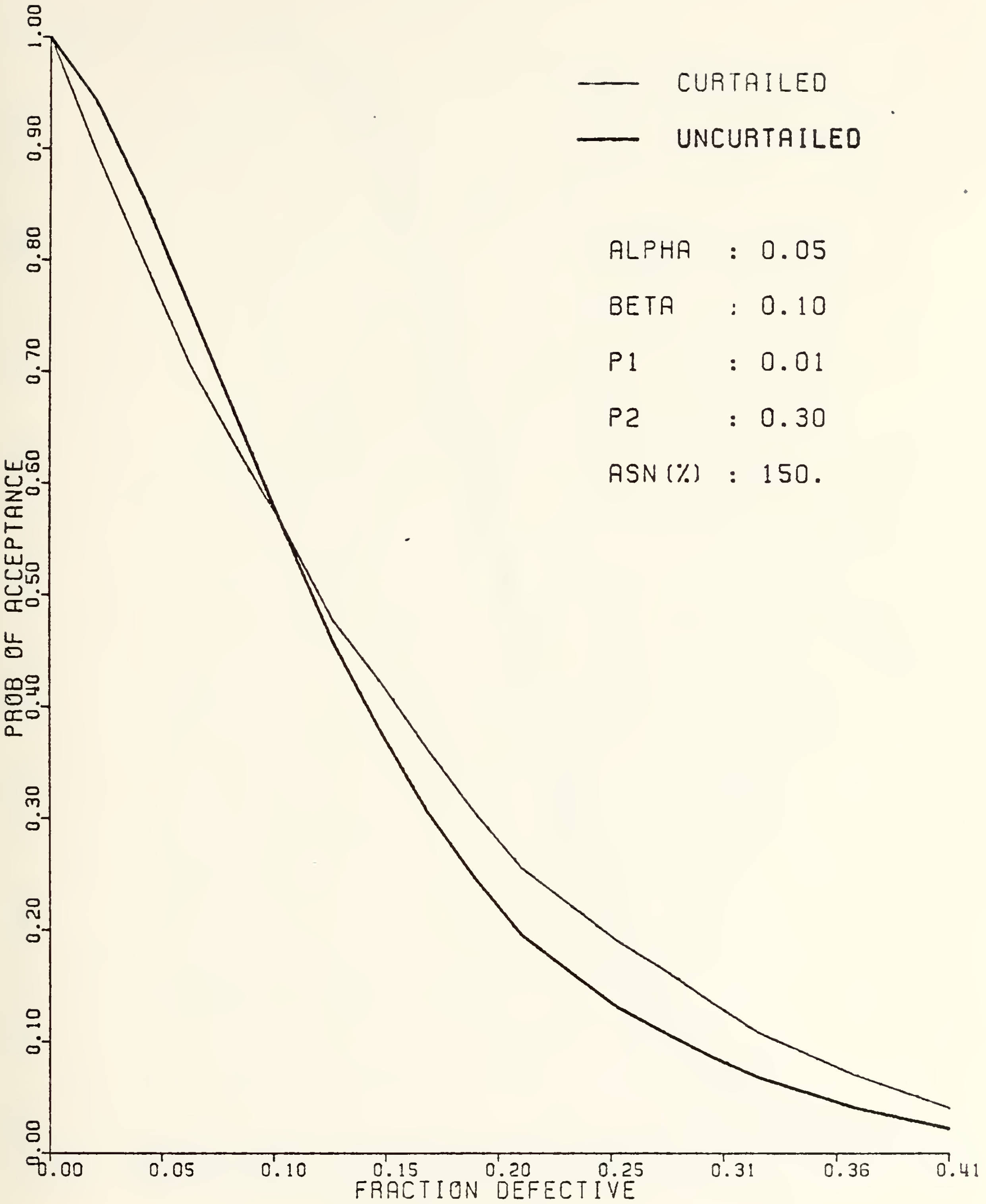

FIGURE 7 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

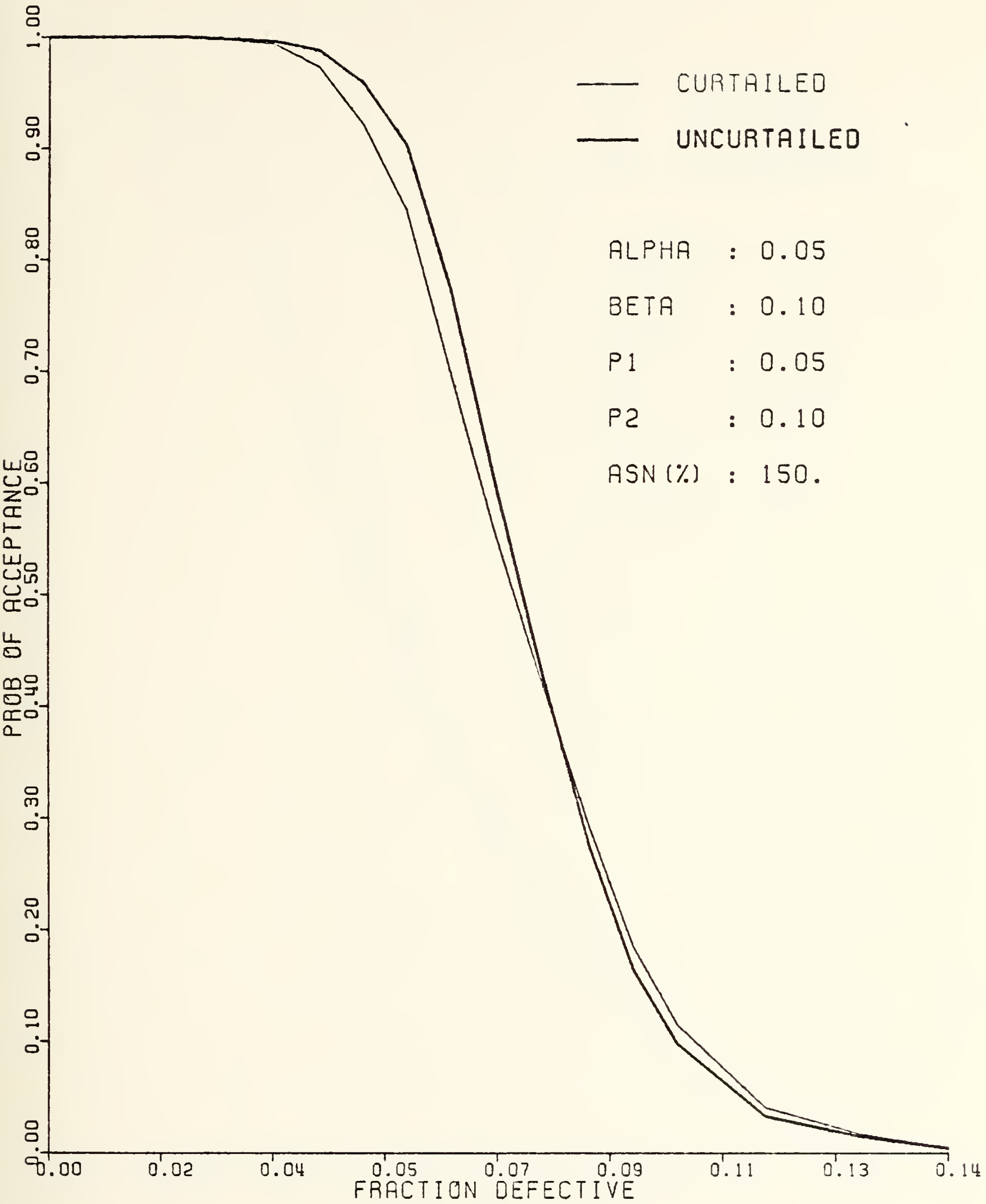

FIGURE 8 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

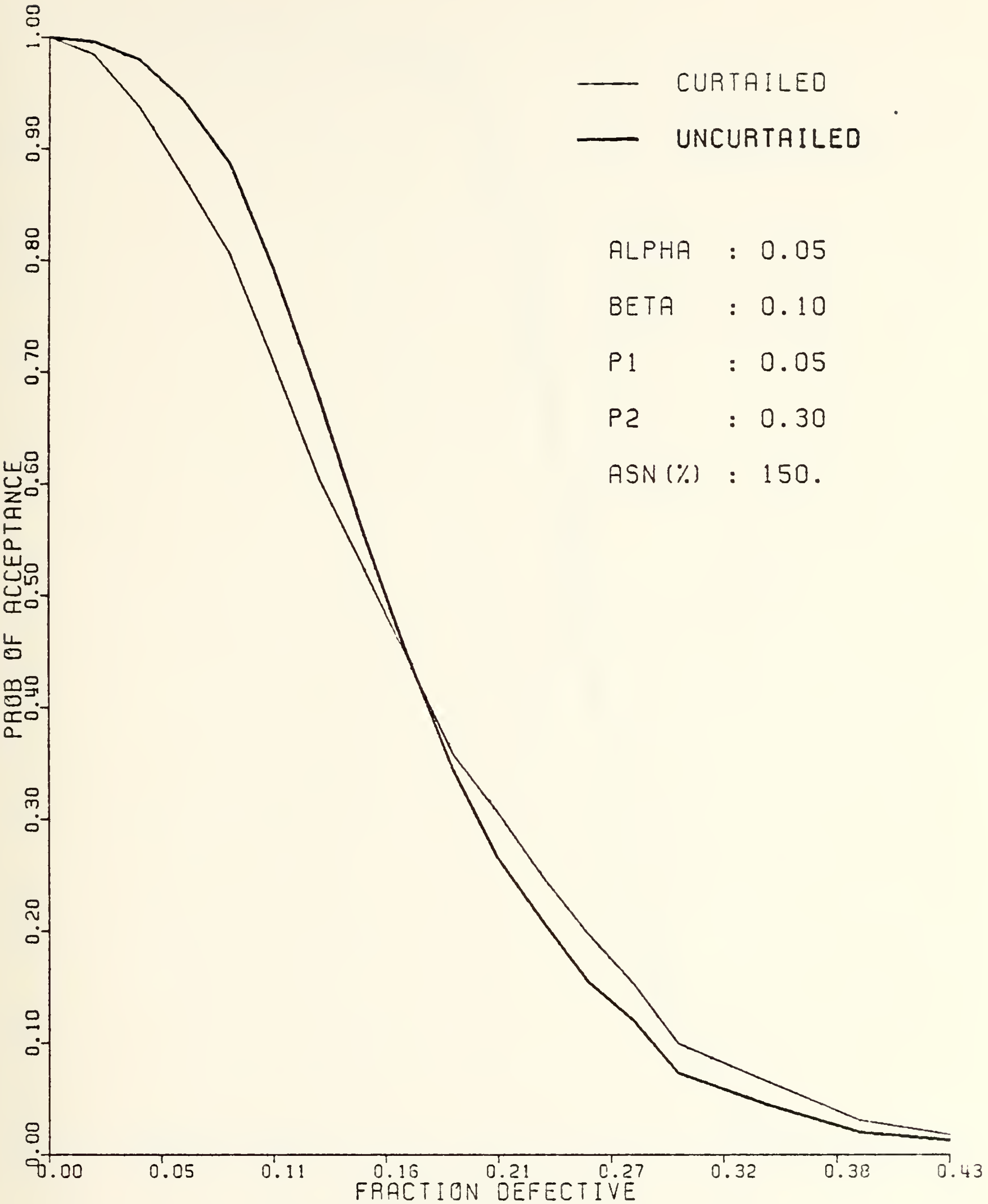

FIGURE 9 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

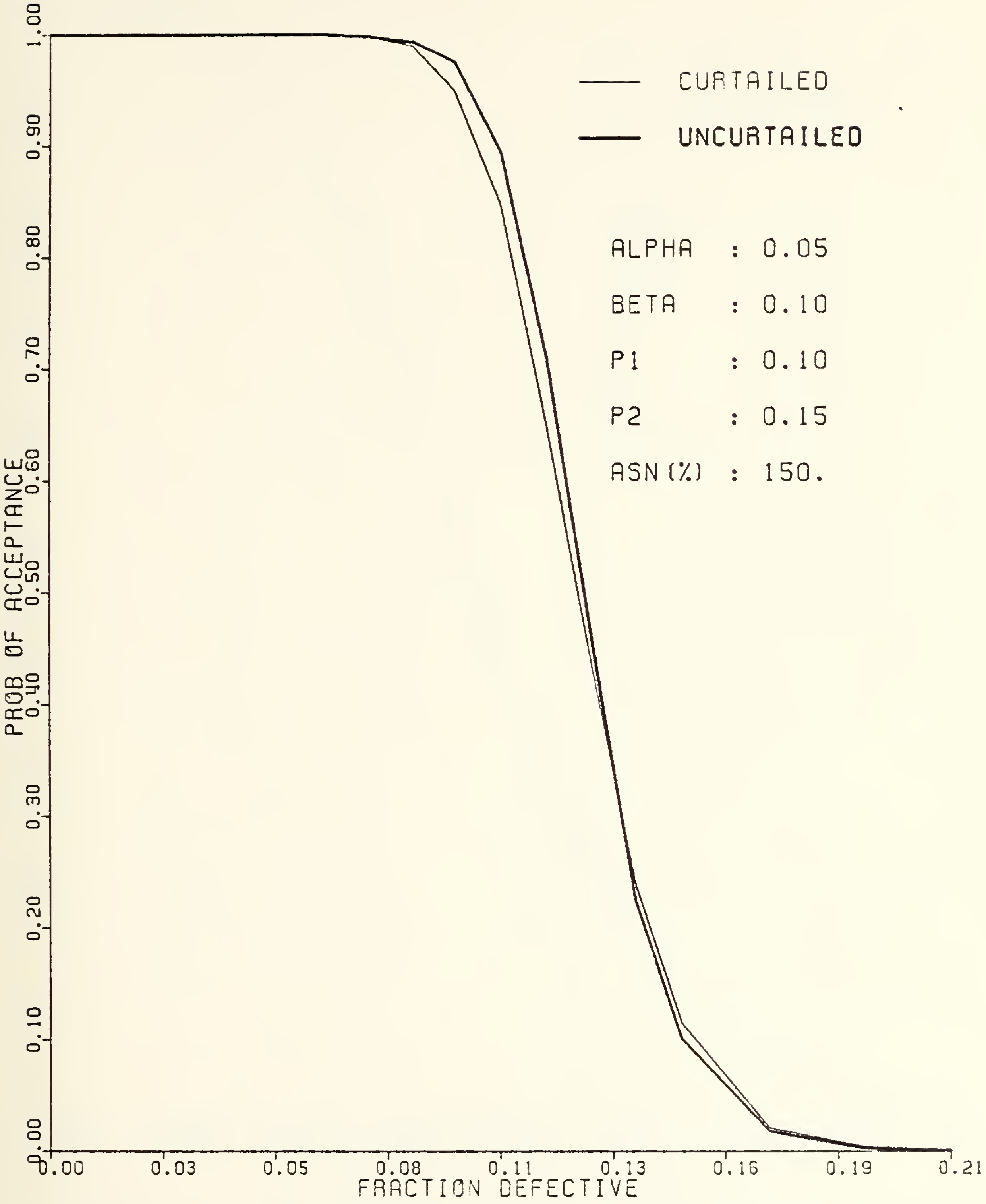

FIGURE 10 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

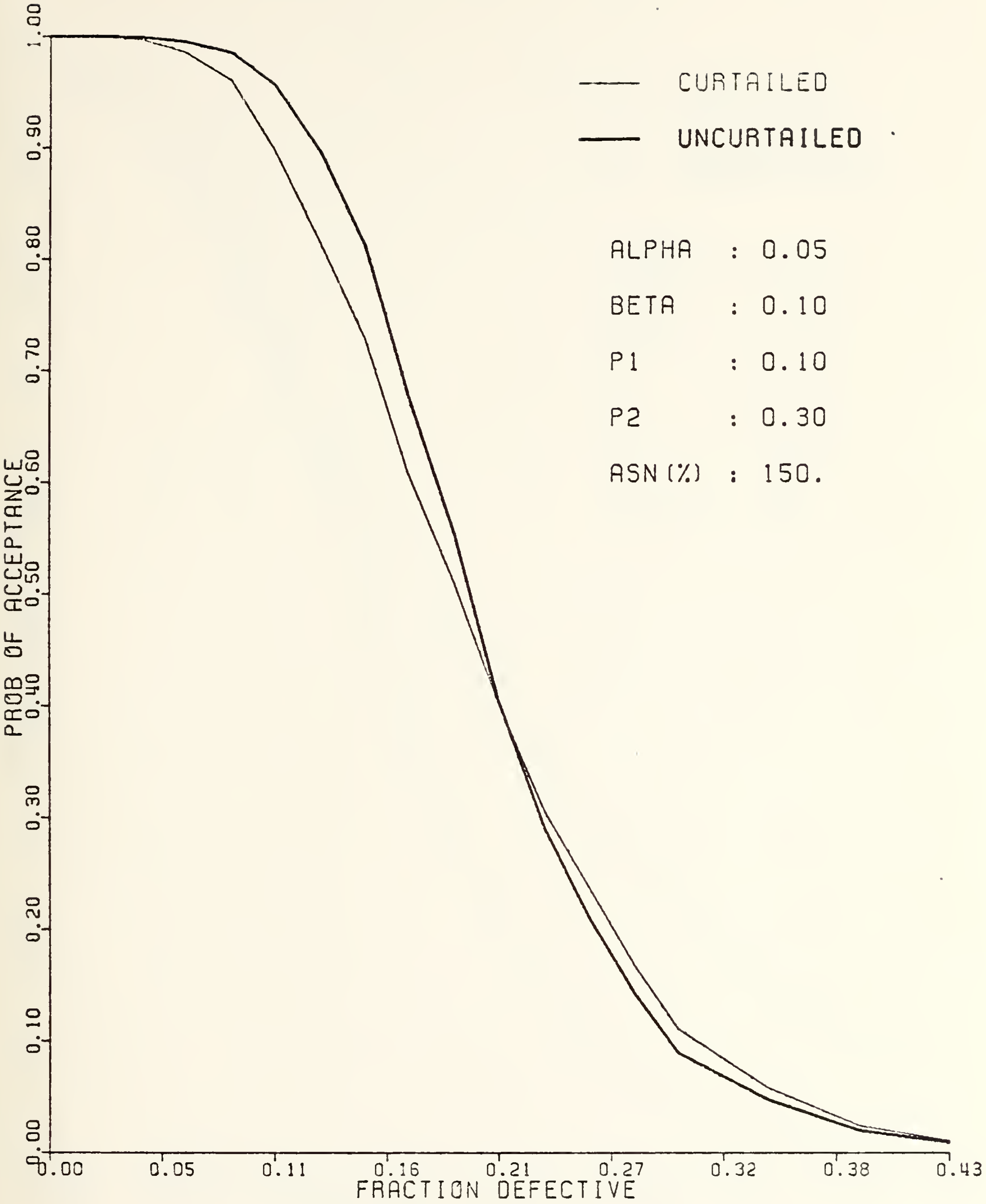

FIGURE 11 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LEAST SQUARE LINE METHOD

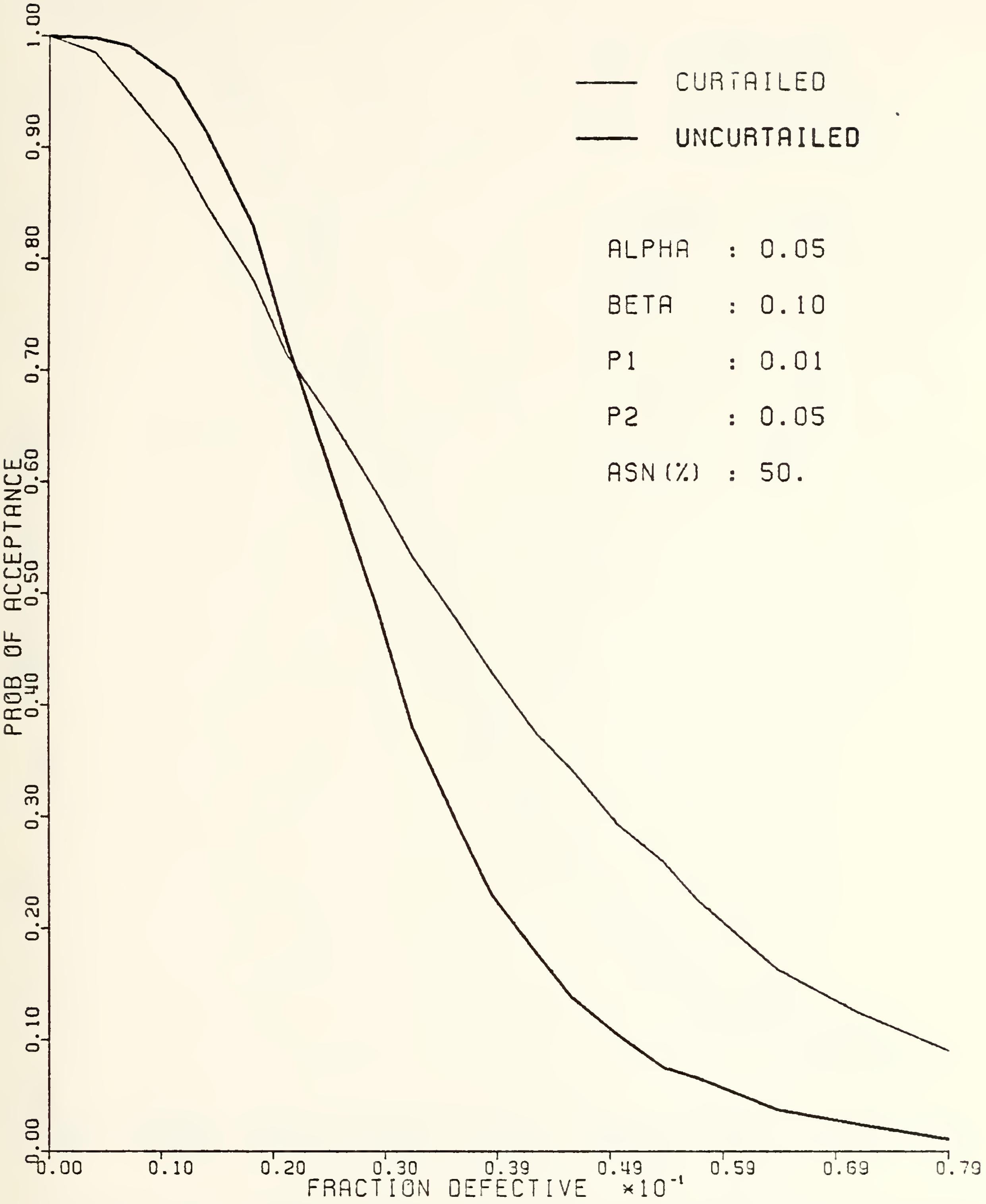

FIGURE 12. OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

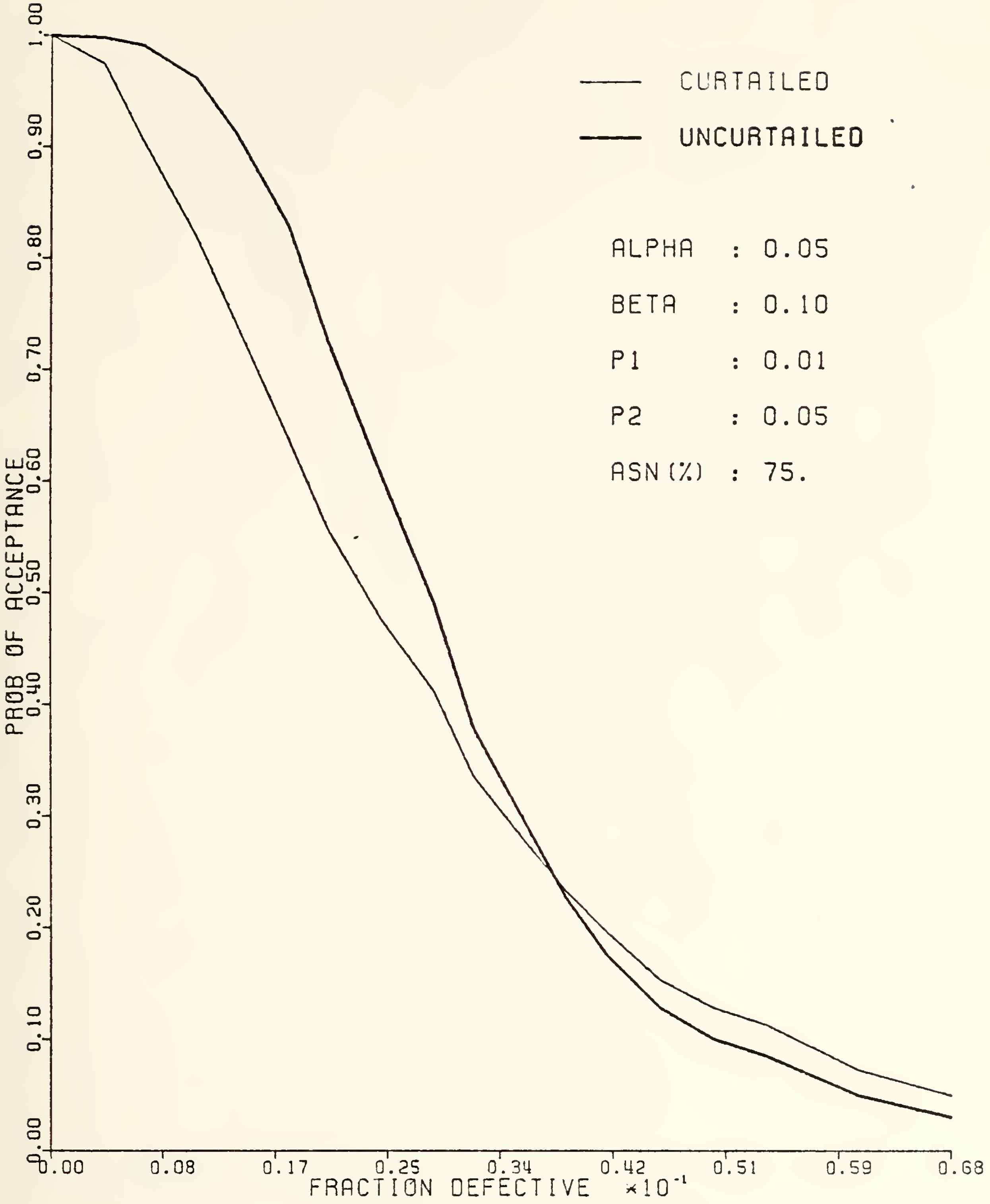

FIGURE 13 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

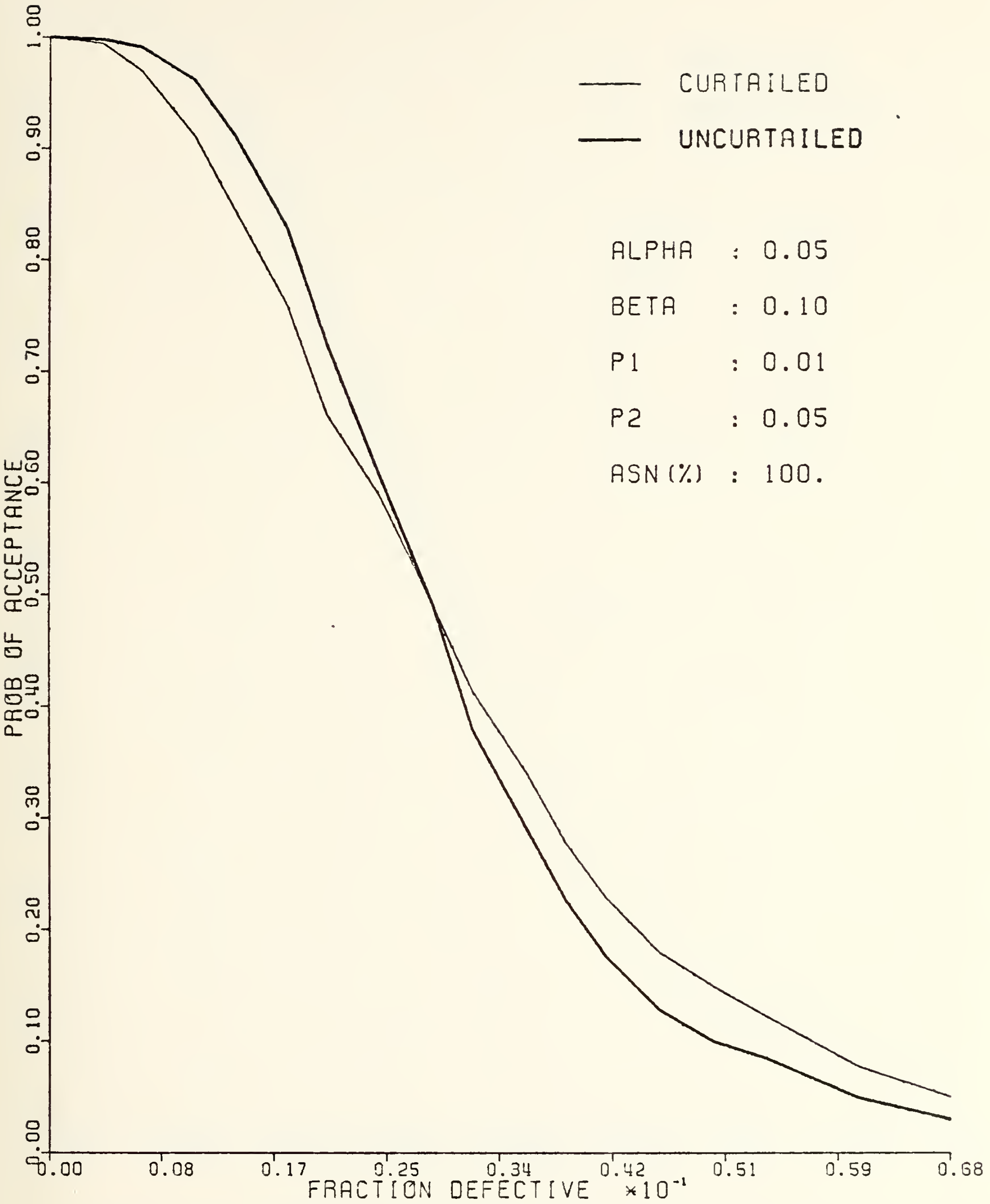

FIGURE 14 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

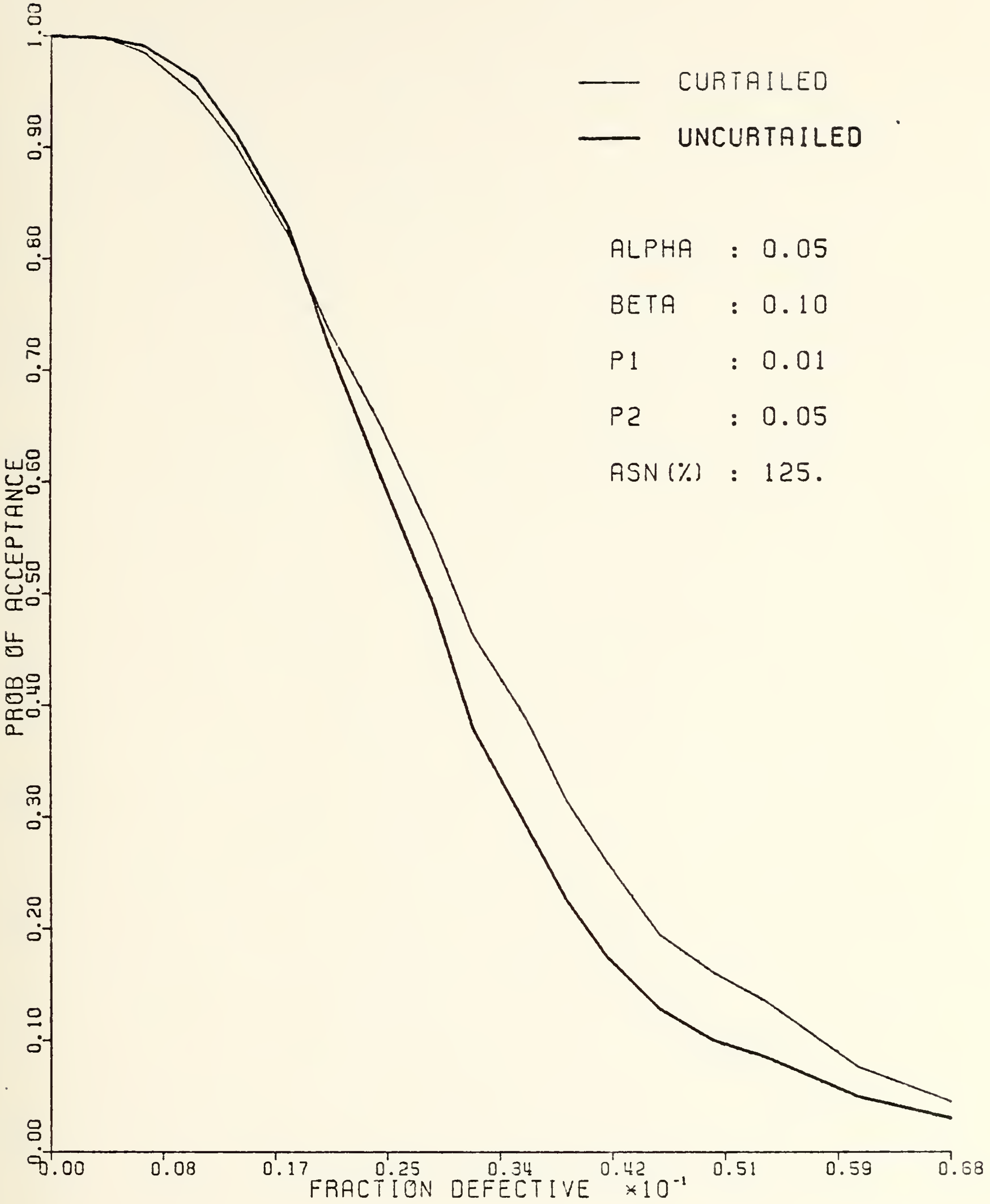

FIGURE 15 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

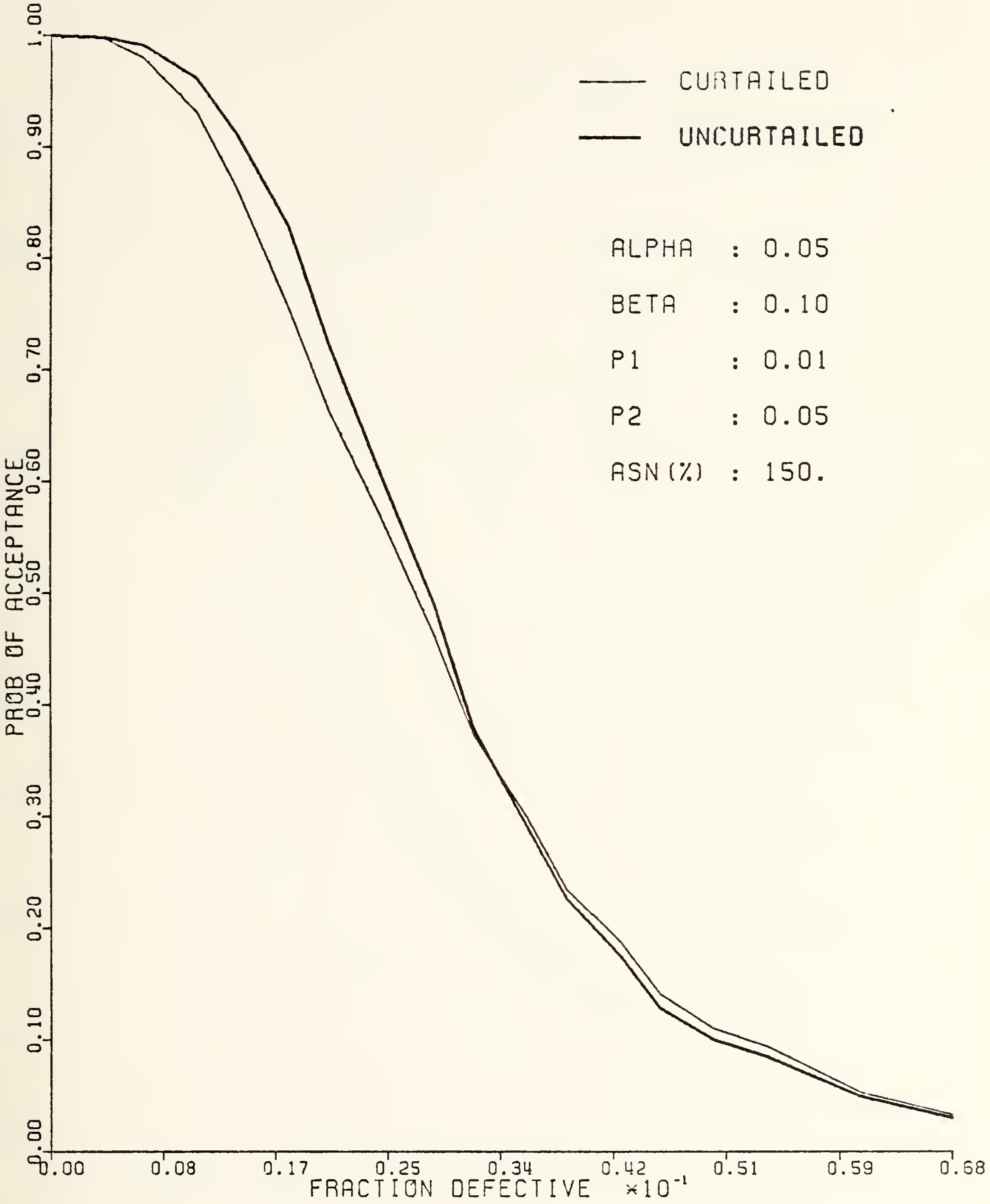

FIGURE 16 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

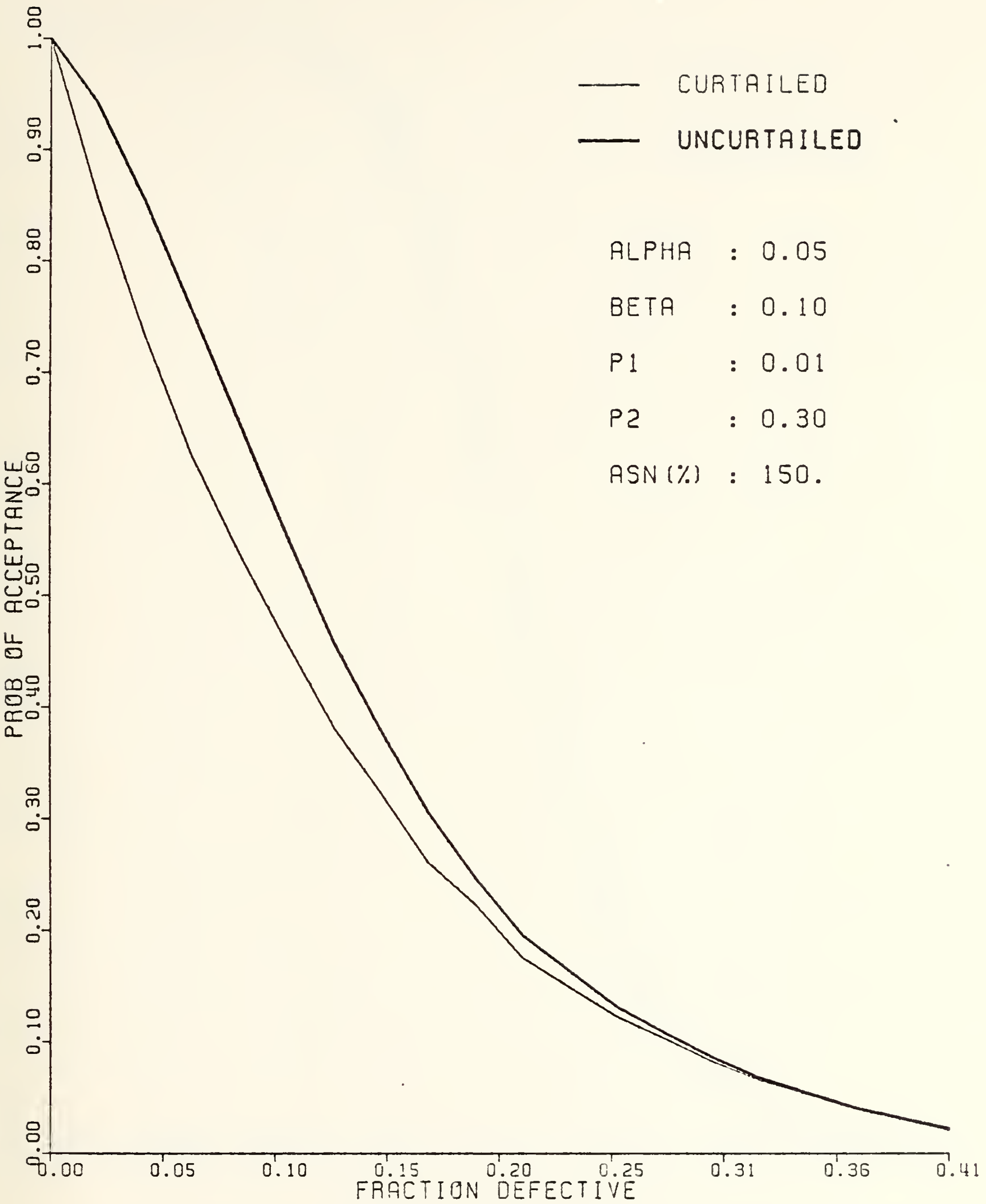

FIGURE 17 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

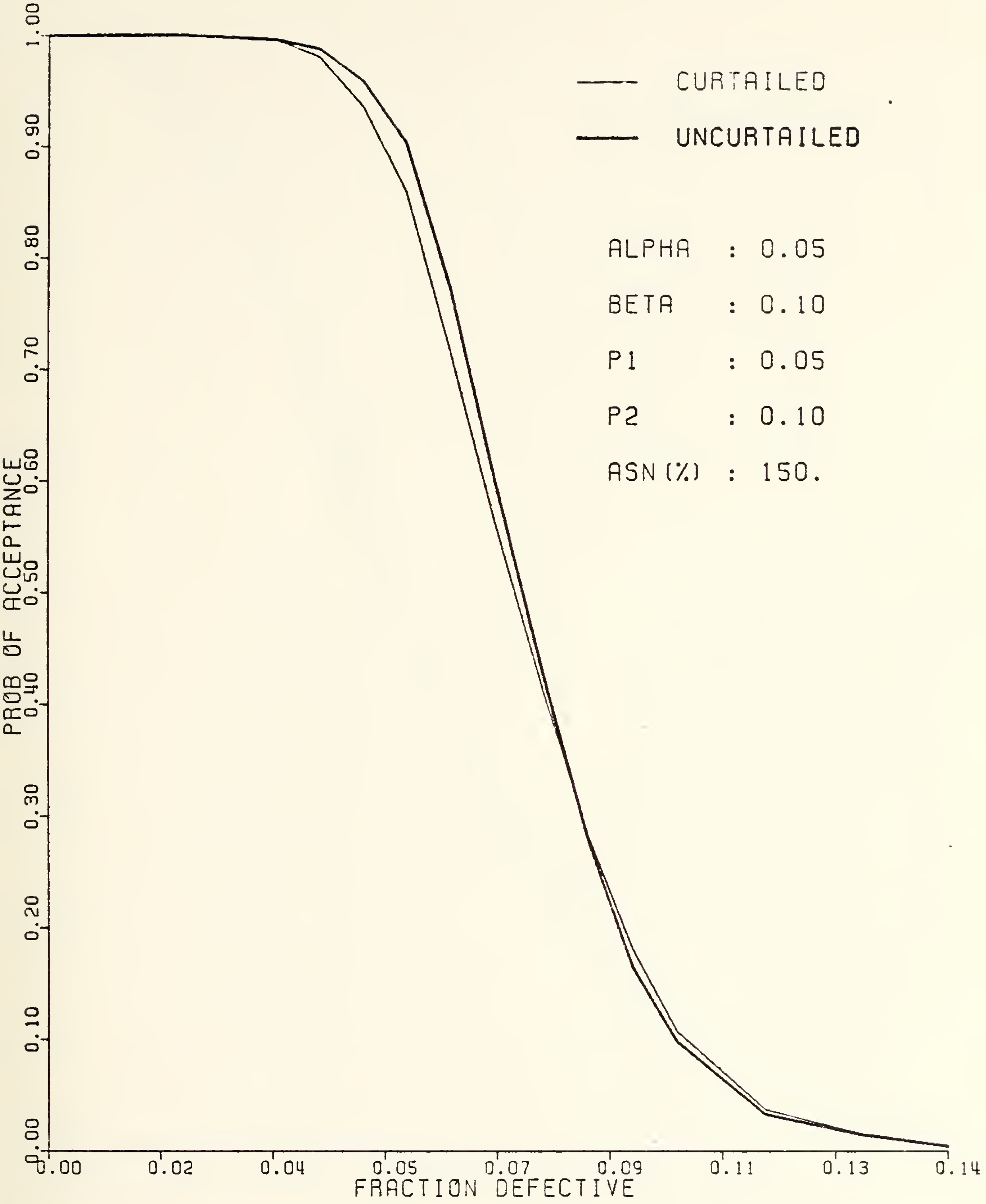

FIGURE 18 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

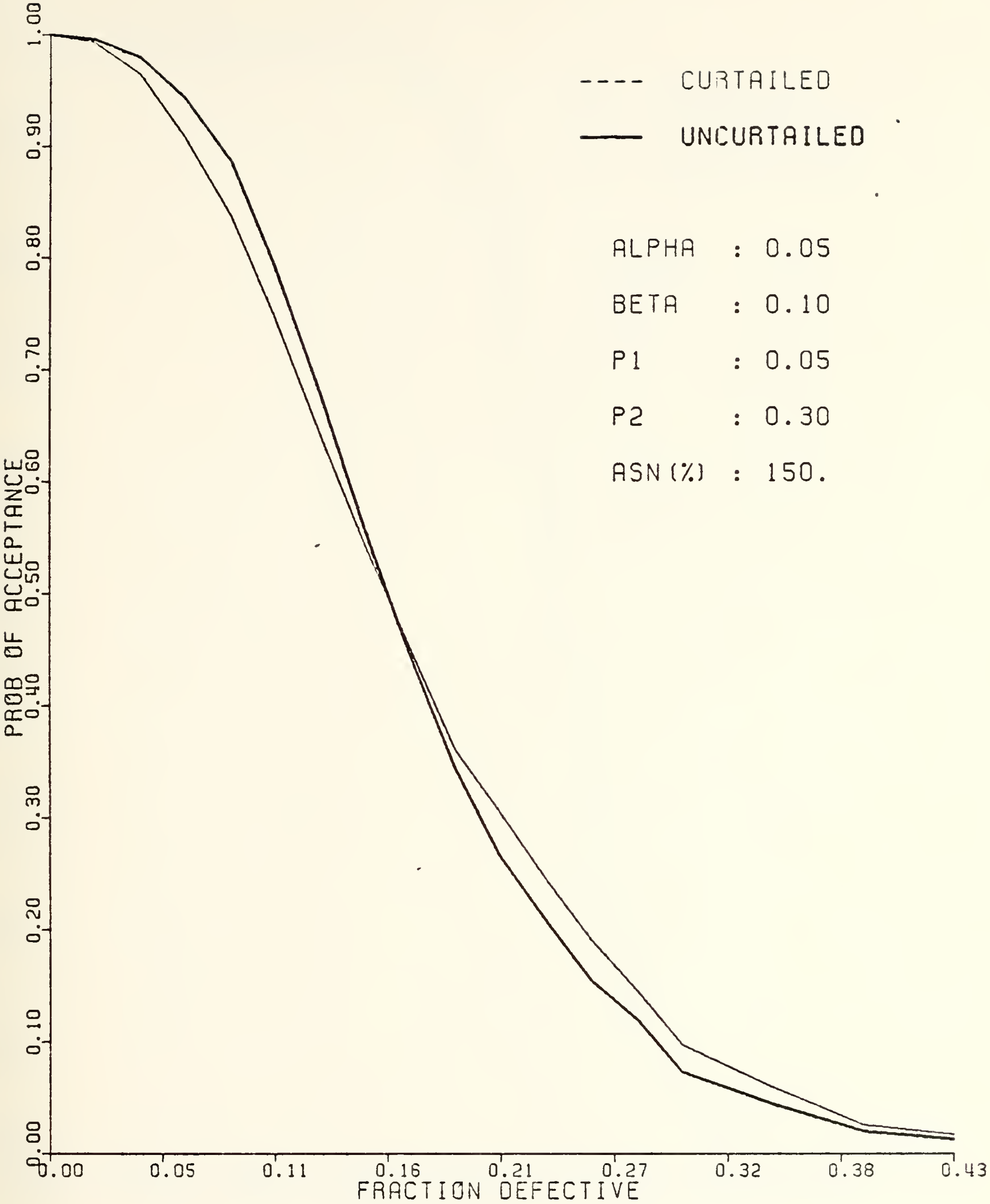

FIGURE 19. OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

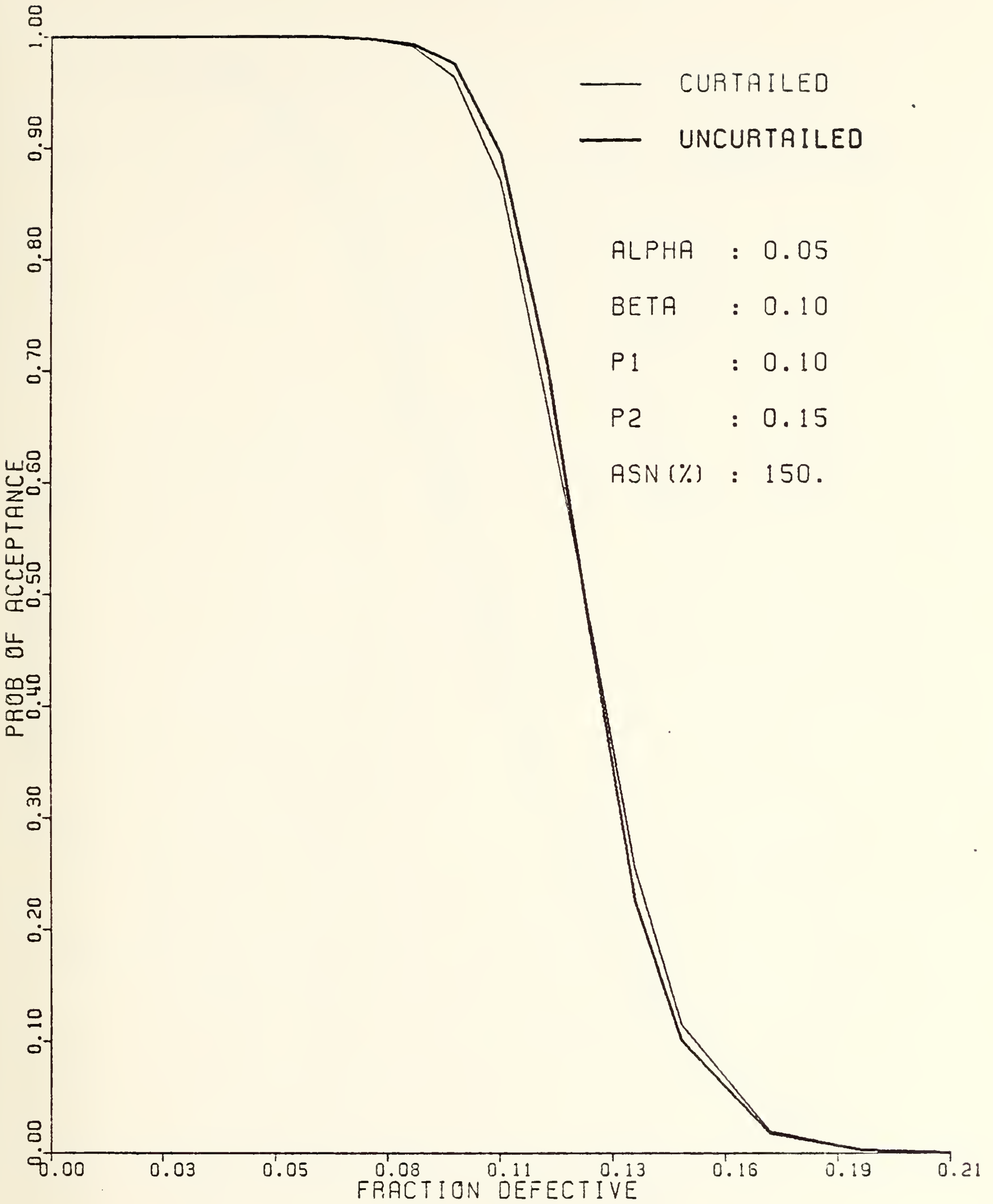

FIGURE 20 . OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

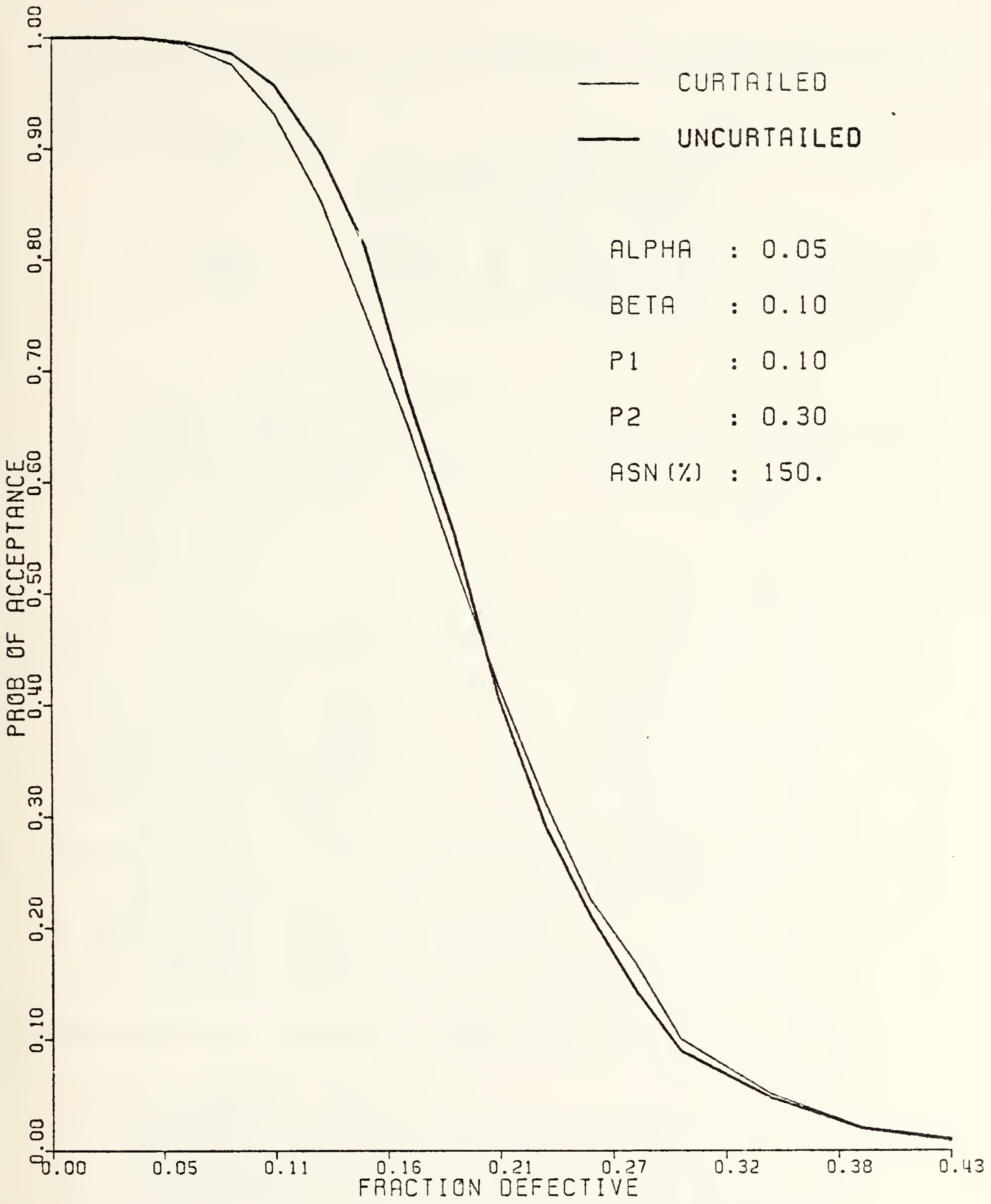

FIGURE 21. OPERATING CHARACTERISTIC CURVE FOR CURTAILED AND UNCURTAILED SAMPLING : LAST OBSERVATION METHOD

COMPUTER PROGRAM I : WALD SPR SAMPLING SIMULATION

```
C  THIS COMPUTER PROGRAM IS TO SIMULATE THE CURTAILED AND
C  UNCURTAILED OF WALD SEQUENTIAL PROBABILITY RATIO SAMPLING
C
C  INPUT VARIABLES ARE
C          1. P1           ACCEPTABLE QUALITY LEVEL
C          2. P2           LOT QUALITY TOLERANCE
C          3. A            TYPE  I  ERROR (ALPHA)
C          4. B            TYPE  II ERROR (BETA)
C          5. NREP         NUMBER OF REPLICATIONS
C          6. NDATA        NUMBER OF POINTS COMPUTED FOR OC CURVE
C                              (MIN OF 5 AND MAX OF 20)
C
C
      IMPLICIT  REAL  (A-H,O-Z)
      REAL *8  DSEED
      DIMENSION  PR(20) ,PWALD(20) ,EXPER1(20) ,EXPER2(20,10),
     * NSTOP(10) ,NA1(10) ,NA2(10)
      DSEED = 625123.0
      ID = 1
      PR(1) = 0.
      PWALD(1) = 1.
C
C  READ IN SPECIFICATION REQUIREMENTS
C
      READ (5,100) P1 ,P2 ,A ,B
      IF (P1.GT.P2)  STOP
      READ (5,101)  NREP
      READ (5,101)  NDATA
      REP = FLOAT(NREP)
C
C  COMPUTE REJECTION AND ACCEPTANCE LINE EQUATIONS
C
      DENOM = ALOG ((P2*(1.-P1))/(P1*(1.-P2)))
      H1 = (ALOG ((1.-A)/B))/DENOM
      H2 = (ALOG  ((1.-B)/A))/DENOM
      S = (ALOG ((1.-P1)/(1.-P2)))/DENOM
C
C  DETERMINE THE POINTS OF TRUNCATION
C
      ASN = (H1*H2)/(S*(1.-S))
      DO  1  I=1,5
        NSTOP(I) = IFIX(ASN*(I*0.25+0.25))
        EXPER1(I) = 1.0
        EXPER2(ID,I) = 1.0
  1   CONTINUE
C
      WRITE (6,108)
      WRITE (6,103)
      WRITE (6,102) P1 ,P2 ,A ,B ,ASN
      WRITE (6,105)
```

```
      WRITE (6,106)  PR(1) ,PWALD(1) ,(EXPER1(I),I=1,5)
      ADD = P2/(NDATA-4)
      P = ADD
C
C  INITIALIZE VARIABLES
C
  2   CONTINUE
      DO  3  I=1,5
        NA1(I) = 0
        NA2(I) = 0
  3   CONTINUE
      ACCEPT = 0.0
C
C  START SIMULATION
C
      DO  7  K=1,NREP
        IN = 1
        DEFECT = 0.0
        CUMDEF = 0.0
C
C  BEGIN TO SAMPLE
C
      DO  6  N=1,10000
        RN = GGUBFS(DSEED)
        IF (RN.LE.P)  DEFECT = DEFECT + 1.
        CUMDEF = CUMDEF + DEFECT
C
C  COMPUTE THE STOPPING BOUNDS
C
        AC = -H1 + S*N
        RE = H2 + S*N
        IF (DEFECT.GE.RE)  GO TO  7
        IF (DEFECT.GT.AC)  GO TO 5
        ACCEPT = ACCEPT + 1.0
        DO  4  I=1,5
        IF (N.GT.NSTOP(I))  GO TO 4
        NA1(I) = NA1(I) + 1
        NA2(I) = NA2(I) + 1
  4     CONTINUE
        GO TO  7
C
C  EXPERIMENT  I  : LEAST SQUARE FITTED LINE  METHOD
C
  5     CONTINUE
        IF (IN.GT.5)  GO TO 6
        IF (N.NE.NSTOP(IN))  GO TO 6
        CUMNO = (1+NSTOP(IN))*NSTOP(IN)*0.5
        SLOPE = CUMDEF/CUMNO
        IF (SLOPE.LE.S)  NA1(IN) = NA1(IN) + 1
C
C  EXPERIMENT  II :  LOCATION OF LAST OBSERVATION  METHOD
C
        IF (DEFECT.LT.(AC+H1))  NA2(IN) = NA2(IN) + 1
        IN = IN + 1
```

```
  6   CONTINUE
  7   CONTINUE
C
C  COMPUTE PROBABILITY OF ACCEPTANCE
C
      ID = ID + 1
      PR(ID) = P
      PWALD(ID) = ACCEPT/REP
      DO  8  K=1,5
        EXPER1(K) = NA1(K)/REP
        EXPER2(ID,K) = NA2(K)/REP
  8   CONTINUE
C
      WRITE (6,106) PR(ID) ,PWALD(ID) ,(EXPER1(K),K=1,5)
      P = P + ADD
      IF ((NDATA-ID).LE.3)  P= P + ADD
      IF (ID.LT.NDATA)  GO TO 2
C
C   PRINT OUT THE RESULT OF EXPERIMENT  II
C
      READ (5,101)  NO
      WRITE (6,108)
      WRITE (6,104)
      WRITE(6,102) P1 ,P2 ,A ,B , ASN
      WRITE (6,105)
      DO  9  I=1,NDATA
        WRITE (6,106) PR(I) ,PWALD(I) ,(EXPER2(I,K),K=1,5)
 9    CONTINUE
      WRITE (6,107)
C
 100  FORMAT (4F10.8)
 101  FORMAT (I5)
 108  FORMAT (5X,' TABLE      . OPERATING CHARACTERISTIC CURVE',
     * ' VALUES FOR',/)
 102  FORMAT(17X, ' ACCEPTABLE QUALITY LEVEL (P1) :',F7.3,//,17X,
     * ' LOTS QUALITY TOLERANCE (P2)    :',F7.3,//,17X,
     * ' PROB OF TYPE I  ERROR (ALPHA) :',F7.3,//,17X,
     * ' PROB OF TYPE II ERROR (BETA)  :',F7.3,//,17X,
     * ' AVERAGE SAMPLE NUMBER (NS) :',F6.0,//,
     *  32X,'PERCENT OF NS FOR CURTAILMENT')
 103  FORMAT (17X,' CURTAILED SAMPLING BY LEAST SQUARE LINE ',
     * 'METHOD',/)
 104  FORMAT (17X,' CURTAILED SAMPLING BY LAST OBSERVATION ',
     * 'METHOD',/)
 105  FORMAT  (5X,' FRACDEF',2X,' UNCURT',2X,'!   50    !   ',
     * '75   !   100   !   125   !   150    ',/)
 106  FORMAT (/,6X,F5.3,5X,F5.3,6X,5(F5.3,4X))
 107  FORMAT (////////)
      STOP
      END
```

COMPUTER PROGRAM II : TO PLOT O.C. CURVE

```
C  INPUT VARIABLES ARE

C  1. NPLOT         NUMBER OF O.C. CURVES TO PLOT
C  2. NDATA         NUMBER OF DATA POINTS IN O.C. CURVE
C  3. FR            FRACTION DEFECTIVE DATA ARRAY
C  4. UNCURT        PROB OF ACCEPTANCE FOR UNCURTAILED SAMPLING
C  5. EXPERI        PROB OF ACCEPTANCE FOR CURTAILED SAMPLING

      IMPLICIT REAL  (A-H,O-Z)
      DIMENSION  FR(25), UNCURT(25), EXPERI(25)
      XLONG = 8.
      YLONG = 10.
      XX = 1.0
      YY = 2.5
      FACT = 0.7
      A = 0.05
      B = 0.10
C
C  INITIALIZE THE PLOTTING SYSTEM
      CALL  PLOTS(0,0,0)
      CALL  FACTOR(FACT)
      CALL  PLOT(XX,YY,-3)
C
C  READ IN DATA AND SCALE  THEM
      READ (5,100)  NPLOT
      READ (5,100)  NDATA
      READ (5,101)  (FR(I),I=1,20)
      READ (5,101)  (UNCURT(I),I=1,20)
      CALL  SCALE(FR,XLONG,NDATA,1)
      CALL  SCALE(UNCURT,YLONG,NDATA,1)
C
C  READ IN EXPERIMENT DATA AND SCALE THEM
  1   CONTINUE
      READ (5,102)  (EXPERI(I),I=1,20), P1, P2, ASN, METHOD
      CALL  SCALE(EXPERI,YLONG,NDATA,1)
C
C  DRAW THE X AND Y AXIS
      CALL  AXIS(0.,0.,'PROB OF ACCEPTANCE',18,YLONG,90.,0.,.1)
      FR(NDATA+2) = FR(NDATA) / XLONG
      CALL  AXIS(0.,0.,'FRACTION DEFECTIVE',-18,XLONG,0.,0.,
     * FR(NDATA+2))
C
C  DRAW THE O.C CURVES
      CALL  LINE(FR,EXPERI,NDATA,1,0,0)
      CALL  NEWPEN(3)
      CALL  LINE(FR,UNCURT,NDATA,1,0,0)
C
C  ANNOTATE THE  PLOT
      CALL  SYMBOL(4.7,9.00,.15,'----  UNCURTAILED',0,17)
```

```
      CALL  NEWPEN(1)
      CALL  SYMBOL(4.7,9.50,.15,'----  CURTAILED  ',0,17)
      CALL  SYMBOL(5.0,8.0,.15,'ALPHA  : ',0,9)
      CALL  NUMBER(999.,999.,.15,A ,0.,2)
      CALL  SYMBOL(5.0,7.5,.15,'BETA   : ',0,9)
      CALL  NUMBER(999.,999.,.15,B ,0.,2)
      CALL  SYMBOL(5.0,7.0,.15,'P1     : ',0,9)
      CALL  NUMBER(999.,999.,.15,P1,0.,2)
      CALL  SYMBOL(5.0,6.5,.15,'P2     : ',0,9)
      CALL  NUMBER(999.,999.,.15,P2,0.,2)
      CALL  SYMBOL(5.0,6.0,.15,'ASN(%) : ',0,9)
      CALL  NUMBER(999.,999.,.15,ASN,0.,0)
      CALL  SYMBOL(0.0,-1.0,.15,'FIGURE     . OPERATING
    *CHARATERISTIC CURVE FOR CURTAILED  ',0,56)
      IF (METHOD.EQ.2)  GO TO  2
      CALL  SYMBOL(0.0,-1.6,.15,'AND UNCURTAILED SAMPLING :
    *LEAST SQUARE LINE METHOD  ',0,51)
      GO TO  3
  2   CONTINUE
      CALL  SYMBOL(0.0,-1.6,.15,'AND UNCURTAILED SAMPLING :
    *LAST OBSERVATION METHOD  ',0,50)
  3   CONTINUE
C
C  DRAW THE NEXT PLOT OR STOP
      NPLOT = NPLOT - 1
      IF (NPLOT.LE.0) GO TO  4
      CALL  PLOT(0.,0.,-999)
      CALL  FACTOR(FACT)
      CALL  PLOT(XX,YY,-3)
      GO TO  1
C
  4   CONTINUE
      CALL  PLOT(0.,0.,999)

 100  FORMAT (I2)
 101  FORMAT (16F5.3,/,4F5.3)
 102  FORMAT (16F5.3,/,6F5.3,F5.0,I2)
      STOP
      END
```

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